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Nuytsia

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Department of Biodiversity, Conservation and Attractions

The cover of *Nuytsia* Volume 30 showcases a golden display of *Cephalipterum drummondii* and *Waitzia acuminata* at Karara Rangeland Park in 2016. Photograph by Steve Dillon

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DEPARTMENT OF BIODIVERSITY, CONSERVATION AND ATTRACTIONS
WESTERN AUSTRALIA

Nutysia

Nuytsia is an open access, peer-reviewed journal that publishes original research on the systematics, taxonomy and nomenclature of Australian (particularly Western Australian) plants, algae and fungi.

Descriptions of taxa, revisions, identification guides, nomenclatural and taxonomic issues, systematic analyses and classifications, censuses, and information on invasive species are all considered.

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GOVERNMENT OF WESTERN AUSTRALIA

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SHORT COMMUNICATION

Updates to Western Australia's vascular plant census for 2018

The census database at the Western Australian Herbarium (PERTH), which provides the nomenclature for the website *FloraBase* (Western Australian Herbarium 1998–), lists current names and recent synonymy for Western Australia's native and naturalised vascular plants, as well as algae, bryophytes, lichens, slime moulds and some fungi. The names represented in the census are either sourced from published research or denote as yet unpublished names based on herbarium voucher specimens. We herein summarise the changes made to vascular plant names in this database during 2018.

One hundred and twenty-nine taxa were newly recorded for the State, of which 24 are naturalised and 41 have been added to the *Threatened and Priority Flora list for Western Australia* (Smith & Jones 2018; Western Australian Herbarium 1998–) (Table 1). A total of 185 name changes were made, including the formal publication of 29 phrase-named taxa (Table 2). Plant groups for which a number of name changes were made include *Hydrocotyle* L. (Perkins 2018a, 2018b), *Drosera* L. (Lowrie 2013a, 2013b, 2014), *Lepilaena* Harv. (Ito *et al.* 2016; Macfarlane *et al.* 2017) and *Zygophyllum* L. (transferred to *Roepera* A.Juss. following Beier *et al.* 2003). Numerous phrased-named taxa in the genus *Baeckea* L. were formally published under an expanded circumscription of *Hysterobaeckea* (Nied.) Rye (Rye 2018). Table 2 also includes cases where there has been a change of taxonomic concept, misapplication, exclusion or rank change.

Table 1. New records added to Western Australia's vascular plant census during 2018. *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label; * = naturalised; T, P1–P4 = Conservation Codes for Western Australian flora (Smith & Jones 2018; Western Australian Herbarium 1998–).

New Name	Status	Comments
Acacia prominens G.Don	*	New naturalised record for WA. G.J. Keighery *in litt.* (11/01/2018).
Acacia sp. Binningup (G. Cockerton et al. WB 37784)	P1	K.R. Thiele *in litt.* (02/07/2018).
Acacia sp. Southern Cross (G. Cockerton et al. WB 38518)	P1	G. Cockerton *in litt.* (14/05/2018).
Aglaia brownii Pannell	P1	New record for WA. M. Hislop pers. comm. (23/10/2018).
Angianthus sp. Salmon Gums (G.F. Craig 3074)	P1	M. Hislop *in litt.* (23/05/2018).
Arthropodium sp. Ironstone (J. Bull & J. Waters ONS PJ 36.01)	P2	S. Dillon *in litt.* (08/04/2018).
Beyeria sp. Lake King (P.R. Jefferies 680514)	P2	M. Hislop *in litt.* (27/03/2018).
Bolboschoenus fluviatilis (Torr.) Sojak	P1	New record for WA. M. Hislop *in litt.* (26/04/2018).
Bonnaya tenuifolia (Colsm.) Spreng.	*	New naturalised record for WA. W.R. Barker *in sched.* (06/04/2018).

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New Name	**Status**	**Comments**
Bossiaea moylei Keighery	P2	See Keighery (2018).
Byblis pilbarana Lowrie & Conran		See Lowrie (2014).
Caladenia lateritica K.W.Dixon & Christenh.		See Dixon & Christenhusz (2018b).
Caladenia rosea K.W.Dixon & Christenh.		See Dixon & Christenhusz (2018b).
Calandrinia sp. Edel Land (F. Obbens FO 01/17)	P2	F. Obbens *in litt.* (26/02/2018).
Calandrinia sp. Gypsum (F. Obbens & L. Hancock FO 10/14)		F. Obbens *in litt.* (21/02/2018).
Callistemon citrinus (Curtis) Skeels	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).
Callitris endlicheri (Parl.) F.M.Bailey	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).
Comesperma sabulosum A.J.Ford & Halford	P3	See Ford *et al.* (2017).
Comesperma secundum subsp. *oligotrichum* A.J.Ford & Halford		See Ford *et al.* (2017).
Cucumis myriocarpus Naudin subsp. *myriocarpus*	*	New naturalised record for WA. See Shaik *et al.* (2016).
Cuscuta suaveolens Ser.	*	New naturalised record for WA. G.J. Keighery *in litt.* (04/10/2017).
Desmanthus virgatus (L.) Willd.	*	New naturalised record for WA. G.J. Keighery *in litt.* (12/03/2018).
Diuris sp. South Coast (G. Brockman GBB 3041)		G.B. Brockman & C.J. French *in litt.* (09/06/2018).
Drosera albonotata A.S.Rob., A.T.Cross, Meisterl & A.Fleischm.	P2	See Robinson *et al.* (2018).
Drosera aquatica Lowrie		See Lowrie (2014).
Drosera aurantiaca Lowrie		See Lowrie (2014).
Drosera × *badgingarra* Lowrie & Conran		See Lowrie (2014).
Drosera barrettorum Lowrie		See Lowrie (2014).
Drosera bindoon Lowrie		See Lowrie (2014).
Drosera calycina Planch.		New record for WA. See Lowrie (2014).
Drosera × *carbarup* Lowrie & Conran		See Lowrie (2014).
Drosera coalara Lowrie & Conran		See Lowrie (2014).
Drosera coomallo Lowrie & Conran		See Lowrie (2014).
Drosera cucullata Lowrie		See Lowrie (2014).

New Name	Status	Comments
Drosera depauperata Lowrie & Conran		See Lowrie (2014).
Drosera esperensis Lowrie		See Lowrie (2014).
Drosera fragrans Lowrie		See Lowrie (2014).
Drosera glabriscapa Lowrie		See Lowrie (2014).
Drosera hirsuta Lowrie & Conran		See Lowrie (2014).
Drosera huegelii Endl. var. *huegelii*		New record for WA. See Utz & Gibson (2017).
Drosera huegelii var. *phillmanniana* Y.-A.Utz & R.P.Gibson	P2	See Utz & Gibson (2017).
Drosera indumenta Lowrie & Conran		See Lowrie (2014).
Drosera × *legrandii* Lowrie & Conran		See Lowrie (2014).
Drosera micra Lowrie & Conran		See Lowrie (2014).
Drosera micrantha Lehm.		New record for WA. See Lowrie (2014).
Drosera minutiflora Planch.		New record for WA. See Lowrie (2014).
Drosera × *pingellyensis* Lowrie & Conran		See Lowrie (2014).
Drosera planchonii Planch.		New record for WA. See Lowrie (2014).
Drosera verrucata Lowrie & Conran		See Lowrie (2014).
Eremophila compacta subsp. Kennedy Range (B. Buirchell BB 107)	P2	B. Buirchell *in litt.* (22/11/2017).
Eremophila platycalyx subsp. Granites (D.J. Edinger & G. Marsh DJE 4782)		B. Buirchell *in litt.* (27/11/2017).
Eremophila platycalyx subsp. Ilgarari (B. Buirchell BB 326)		B. Buirchell *in litt.* (22/11/2017).
Eremophila platycalyx subsp. Leonora (J. Morrisey 252)		B. Buirchell *in litt.* (22/11/2017).
Eremophila platycalyx subsp. Neds Creek (N.H. Speck 1228)		B. Buirchell *in litt.* (27/11/2017).
Eremophila platycalyx subsp. Wongawol (N.H. Speck 1291)	P1	B. Buirchell *in litt.* (22/11/2017).
Eremophila platycalyx subsp. Woolgorong (F. Hort et al. FH 3253)		B. Buirchell *in litt.* (22/11/2017).
Eremophila platycalyx subsp. Yalgoo (A. Markey & S. Dillon 3337)	P3	B. Buirchell *in litt.* (22/11/2017).
Eremophila sp. Coodardo Gap (B. Buirchell BB 330)	P1	B. Buirchell *in litt.* (22/11/2017).
Eremophila sp. Mt Channar Range (C. Keating & M.E. Trudgen CK 408)	P1	B. Buirchell *in litt.* (08/05/2018).

New Name	**Status**	**Comments**
Eremophila sp. Pingandy dentate (B. Buirchell BB 331)	P1	B. Buirchell *in litt.* (22/11/2017).
Eremophila sp. Thundelarra (B. Buirchell BB 324)	P1	B. Buirchell *in litt.* (22/11/2017).
Eremophila sp. Tropicana (B. Buirchell BB 323)	P1	B. Buirchell *in litt.* (01/11/2017).
Eremophila sp. Wubin North (R. Wait 8305)	P1	B. Buirchell *in litt.* (22/11/2017).
Erythrina crista-galli L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (15/02/2018).
Eucalyptus revelata D.Nicolle & R.L.Barrett	P2	See Nicolle & Barrett (2018).
Grevillea sp. Victoria Desert (R. Davis et al. RD 11611)	P1	R. Davis *in litt.* (23/10/2018).
Halodule tridentata (Steinh.) Unger		New record for WA. See Kuo (2011).
Hibbertia pubens K.R.Thiele		See Thiele (2018).
Hysterobaeckea setifera Rye		See Rye (2018).
Isotropis sp. Arid zone (G. Byrne 2775)		R. Davis & J.A. Wege *in litt.* (28/03/2018).
Isotropis sp. Yalgoo (S. Patrick 2375)		R. Davis & J.A. Wege *in litt.* (28/03/2018).
Josephinia sp. Northern (T.E.H. Aplin 6360)		W.R. Barker *in litt.* (11/11/2013).
Leucopogon sp. Kirup (M. Hislop 3919)	P2	M. Hislop *in litt.* (02/11/2018).
Limnobium laevigatum (Willd.) Heine	*	New naturalised record for WA. G.J. Keighery *in litt.* (11/01/2018).
Lindernia cyanoplectra W.R.Barker		See Barker (2018).
Lindernia dunlopii W.R.Barker		See Barker (2018).
Lindernia porphyrodinea W.R.Barker & M.D.Barrett		See Barker (2018).
Lindernia sp. Minute-flowered (A.S. George 12433)	P2	W.R. Barker *in litt.* (18/07/2018).
Lindernia sp. Pilbara (M.N. Lyons & L. Lewis FV 1069)	P1	W.R. Barker & M. Lyons *in litt.* (18/07/2018).
Melaleuca quinquenervia (Cav.) S.T.Blake	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).
Microcorys sp. Mt Holland (D. Angus DA 2397)	P1	M. Hislop *in litt.* (01/12/2017).
Nymphaea pubescens Willd.	*	New naturalised record for WA. M.D. Barrett & E. Dalziell *in litt.* (04/12/2017).
Olearia sp. Gregory (M. Hislop 3784)	P1	M. Hislop *in litt.* (11/07/2018).
Paracaleana sp. Laterite (G. Brockman GBB 3571)	P2	G. Brockman & A. Brown *in litt.* (18/04/2018).

New Name	Status	Comments
Pelargonium × *hortorum* L.H.Bailey	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).
Pentameris patula (Nees) Steud.	*	New naturalised record for WA. T.D. Macfarlane *in litt.* (22/08/2018).
Petrophile brevifolia Lindl. subsp. *brevifolia*		New record for WA. See Keighery & Keighery (2017).
Petrophile brevifolia subsp. *rosea* B.J.Keighery & Keighery		See Keighery & Keighery (2017).
Polymeria mollis (Benth.) Domin		New record for WA. D.A. Halford *in litt.* (17/10/2018).
Pterostylis arbuscula (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis atrosanguinea (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis ectypha (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis faceta (D.L.Jones, C.J.French & M.A.Clem.) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis galgula (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis longicornis (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis orbiculata (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis precatoria (D.L.Jones, C.J.French & M.A.Clem.) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis saxosa (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis serotina (D.L.Jones, C.J.French & M.A.Clem.) D.L.Jones & C.J.French		See Jones & French (2018).
Pterostylis sigmoidea (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2018).
Ptilotus yapukaratja R.W.Davis & T.Hammer	P1	See Davis & Hammer (2018).
Quercus palustris Münchh.	*	New naturalised record for WA. See Lohr & Keighery (2016).
Quercus robur L.	*	New naturalised record for WA. See Lohr & Keighery (2016).
Ranunculus repens L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).
Rhizanthella johnstonii K.W.Dixon & Christenh.	T	See Dixon & Christenhusz (2018a).
Salvia misella Kunth	*	New naturalised record for WA. M. Hislop pers. comm. (23/10/2018).
Scaevola sp. Mt Ragged (M. Goods GG 004)	P2	B. Maslin & R. Davis *in litt.* (23/01/2012).
Scholtzia sp. Coburn (N. Murdock NM 031)	P2	B.L. Rye *in litt.* (03/04/2018).
Scholtzia sp. Overlander (M.E. Trudgen 12138)	P1	B.L. Rye *in litt.* (08/05/2018).

New Name	Status	Comments
Sida fallax Walp.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).
Solanum nitidibaccatum Bitter	*	New naturalised record for WA. See Särkinen *et al.* (2018).
Solanum sp. Red Hill (S. van Leeuwen et al. PBS 5415)	P3	A.A. Mitchell *in litt.* (01/05/2018).
Stemodia sp. Carnarvon (W.R. Barker 2154)		W.R. Barker *in litt.* (06/04/2018).
Stemodia sp. Doongan (R.L. Barrett RLB 4704)		W.R. Barker *in litt.* (26/09/2013).
Stemodia sp. Shay Gap (B. Cook 7)		W.R. Barker *in litt.* (26/09/2013).
Styphelia sp. Stirling Range (R.D. Royce 6087)		M. Hislop *in litt.* (30/11/2017).
Styphelia sp. Tarin Rock (W.E. Blackall 1315)	P1	M. Hislop *in litt.* (12/07/2018).
Thinopyrum ponticum (Podp.) Barkworth & D.R.Dewey	*	New naturalised record for WA. G.J. Keighery *in litt.* (28/01/2016).
Thymophylla tenuiloba (DC.) Small	*	New naturalised record for WA. V. Stajsic *in litt.* (19/01/2018).
Thymophylla tenuiloba (DC.) Small var. *tenuiloba*	*	New naturalised record for WA. V. Stajsic *in litt.* (19/01/2018).
Ursinia nana DC.	*	New naturalised record for WA. See Keighery & Keighery (2018).
Ursinia nana DC. subsp. *nana*	*	New naturalised record for WA. G.J. Keighery *in litt.* (21/07/2018).
Utricularia albertiana R.W.Jobson & Baleeiro	P1	See Jobson *et al.* (2018).
Utricularia bidentata R.W.Jobson & Baleeiro	P3	See Jobson *et al.* (2018).
Utricularia foveolata Edgew.		New record for WA. See Lowrie (2014).
Utricularia magna R.W.Jobson & M.D.Barrett	P2	See Jobson *et al.* (2018).
Utricularia nivea Vahl		New record for WA. M.D. Barrett *in litt.* (12/12/2017).
Utricularia papilliscapa R.W.Jobson & M.D.Barrett	P2	See Jobson *et al.* (2018).
Verticordia sp. Koolyanobbing (B.H. Smith 1457)	P1	B.L. Rye *in litt.* (03/04/2018).

Table 2. Changes to existing entries in Western Australia's vascular plant census during 2018. Excluded taxon = a name used in the botanical literature that refers to a taxon never occurring in WA; misapplied name = a name used in the botanical literature but now considered to refer to one or more different WA taxa; nomenclatural synonym = a superseded name based on the same type specimen as the accepted name—the epithet is usually transferred to a different genus name or rank; taxonomic synonym = a superseded name based on a different type specimen to the accepted name; orthographic variant = mis-spelling of a name in original publication; *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; T, P1–P4 = Conservation Codes for Western Australian flora (Smith & Jones 2018; Western Australian Herbarium 1998–).

Old Name	New Name	Status	Comments
Aristida personata Henrard	n/a		Excluded taxon. S.J. Dillon *in sched.* (30/10/2018).
Baeckea sp. Barbalin (B.L. Rye & M.E. Trudgen BLR 241022)	*Hysterobaeckea petraea* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Bencubbin-Koorda (M.E. Trudgen 5421)	*Hysterobaeckea setifera* subsp. *meridionalis* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Boorabbin (J.H. Willis s.n. 4/10/1961)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Bulla Bulling (D.J.E. Whibley 4648)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Bungalbin Hill (B.J. Lepschi & L.A. Craven 4586)	*Hysterobaeckea cornuta* Rye	P3	Name synonymised. See Rye (2018).
Baeckea sp. Comet Vale (A.S. George 8078)	*Hysterobaeckea ochropetala* subsp. *cometes* Rye	P3	Taxon formally published. See Rye (2018).
Baeckea sp. Coolgardie (A. Strid 21320)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Die Hardy Range (E. Mattiske J91)	*Hysterobaeckea cornuta* Rye	P3	Name synonymised. See Rye (2018).
Baeckea sp. Exclamation Lake (M.E. Trudgen 1524)	*Hysterobaeckea* sp. Exclamation Lake (M.E. Trudgen 1524)	P1	Name synonymised. See Rye (2018).
Baeckea sp. Fitzgerald Peaks (P.J. Poli 53)	*Hysterobaeckea graniticola* Rye	P2	Taxon formally published. See Rye (2018).
Baeckea sp. Flying Fox Mine (A.O'Connor & V. Longman FF532)	*Hysterobaeckea pterocera* Rye	P1	Taxon formally published. See Rye (2018).
Baeckea sp. Gnarlbine Rocks (G. Barrett GRH469)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Kalgarin Hill Road (A.M. Lyne, L. Craven & F. Zich AML1018)	*Hysterobaeckea glandulosa* Rye	P1	Taxon formally published. See Rye (2018).
Baeckea sp. Lake Brown (E. Merrall s.n. 1889)	*Hysterobaeckea ochropetala* (F.Muell.) Rye subsp. *ochropetala*	P1	Name synonymised. See Rye (2018).
Baeckea sp. Lake Campion (A. Coates AC 2285)	*Hysterobaeckea setifera* subsp. *meridionalis* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Melita Station (H. Pringle 2738)	*Hysterobaeckea occlusa* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Mt Clara (R.J. Cranfield 11693)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Mt Clifford (B. Severne 74002)	*Hysterobaeckea occlusa* Rye		Name synonymised. See Rye (2018).

Old Name	**New Name**	**Status**	**Comments**
Baeckea sp. Mt Jackson (G.J. Keighery 4362)	*Hysterobaeckea cornuta* Rye	P3	Name synonymised. See Rye (2018).
Baeckea sp. Pigeon Rocks (D. Grace DJP 281)	*Hysterobaeckea petraea* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Queen Victoria Rock (K.R. Newbey 6103)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Roundtop Hill (P. Armstrong 05/843)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Ubini (R. Pullen 9610)	*Hysterobaeckea ochropetala* subsp. *reliqua* Rye		Name synonymised. See Rye (2018).
Baeckea sp. Wanarra (M.E. Trudgen MET 5376)	*Hysterobaeckea setifera* Rye subsp. *setifera*		Name synonymised. See Rye (2018).
Baeckea sp. Wubin (M.E. Trudgen 5404)	*Hysterobaeckea longipes* Rye		Taxon formally published. See Rye (2018).
Bartsia trixago L.	*Bellardia trixago* (L.) All.	*	Nomenclatural synonym. See Uribe-Convers & Tank (2016).
Borya jabirabela Churchill	n/a		Excluded taxon. M.D. Barrett *in litt.* (04/09/2018).
Borya sp. Synnot Range (M.D. Barrett MDB 444)	*Borya stenophylla* M.D.Barrett	P1	Taxon formally published. See Barrett (2018).
Bossiaea sp. Bremer (K. Newbey 2980)	*Bossiaea lalagoides* F.Muell.	P3	Name synonymised. See Keighery (2018).
Bossiaea sp. Cairn Hill (M. Henson MJH 2-28)	*Bossiaea moylei* Keighery	P2	Taxon formally published. See Keighery (2018).
Bossiaea sp. Waroona (B.J. Keighery & N. Gibson 229)	*Bossiaea angustifolia* (Meisn.) Keighery		Name synonymised. See Keighery (2018).
Caesalpinia gilliesii (Hook.) D.Dietr.	*Erythrostemon gilliesii* (Hook.) Klotzsch	*	Nomenclatural synonym. See Gagnon *et al.* (2016).
Caladenia lateritica K.W.Dixon & Christenh.	*Caladenia flava* subsp. *sylvestris* Hopper & A.P.Br.		Taxonomic synonym. A.P. Brown *in sched.* (23/05/2018).
Caladenia rosea K.W.Dixon & Christenh.	*Caladenia* × *spectabilis* Hopper & A.P.Br.		Taxonomic synonym. A.P. Brown *in sched.* (23/05/2018).
Calandrinia sp. Goongarrie (F. Obbens, F. Hort & J. Hort FO 18/13)	*Calandrinia quartzitica* Obbens	P1	Taxon formally published. See Obbens (2018).
Calandrinia sp. Meckering (F. Obbens 42/02)	*Calandrinia wilsonii* Obbens	P2	Taxon formally published. See Obbens (2018).
Calandrinia sp. Widgiemooltha (F. Obbens & E. Reid FO 9/05)	*Calandrinia lefroyensis* Obbens	P1	Taxon formally published. See Obbens (2018).
Callitris huegelii J.W.Green	*Callitris glaucophylla* Joy Thomps. & L.A.S.Johnson		Misapplied name. A name of uncertain application. See Thompson & Johnson (1986).
Cayratia trifolia (L.) Domin	*Causonis trifolia* (L.) Mabb. & J.Wen		Nomenclatural synonym. See Mabberley (2017).
Celtis philippensis Blanco	*Celtis strychnoides* Planch.		Misapplied name. See Guymer (2013).
Chionachne cyathopoda (F.Muell.) Benth.	*Polytoca cyathopoda* (F.Muell.) F.M.Bailey		Nomenclatural synonym. See Mabberley (2017).

Old Name	New Name	Status	Comments
Chionachne hubbardiana Henrard	*Polytoca hubbardiana* (Henrard) Mabb.		Nomenclatural synonym. See Mabberley (2017).
Citrullus lanatus (Thunb.) Matsum. & Nakai	*Citrullus amarus* Schrad.	*	Misapplied name. See Chomicki & Renner (2015).
Comesperma pallidum Pedley	*Comesperma sabulosum* A.J.Ford & Halford	P3	Misapplied name. See Ford *et al.* (2017).
Commersonia cygnorum Steud.	*Commersonia corniculata* (Sm.) K.A.Sheph. & C.F.Wilkins		Taxonomic synonym. See Shepherd & Wilkins (2018a).
Corunastylis tepperi (Tepper) D.L.Jones & M.A.Clem.	*Corunastylis fuscoviridis* (Reader) D.L.Jones & M.A.Clem.		Misapplied name. A.P. Brown *in sched.* (18/04/2018).
Cynanchum carnosum (R.Br.) Schltr.	*Vincetoxicum carnosum* (R.Br.) Benth.		Nomenclatural synonym. See Liede-Schumann & Meve (2018).
Davenportia davenportii (F.Muell.) R.W.Johnson	*Distimake davenportii* (F.Muell.) A.R.Simões & Staples		Nomenclatural synonym. See Simões & Staples (2017).
Drosera brevicornis Lowrie	n/a		Excluded taxon. See Lowrie (2013a).
Drosera bulbosa subsp. *major* (Diels) N.G.Marchant & Lowrie	*Drosera major* (Diels) Lowrie		Nomenclatural synonym. See Lowrie (2014).
Drosera erythrorhiza subsp. *collina* N.G.Marchant & Lowrie	*Drosera collina* (N.G.Marchant & Lowrie) Lowrie		Nomenclatural synonym. See Lowrie (2014).
Drosera erythrorhiza Lindl. subsp. *erythrorhiza*	*Drosera erythrorhiza* Lindl.		Nomenclatural synonym. No subspecies recognised. See Lowrie (2013a).
Drosera erythrorhiza subsp. *magna* N.G.Marchant & Lowrie	*Drosera magna* (N.G.Marchant & Lowrie) Lowrie		Nomenclatural synonym. See Lowrie (2014).
Drosera erythrorhiza subsp. *squamosa* (Benth.) N.G.Marchant & Lowrie	*Drosera squamosa* Benth.		Nomenclatural synonym. See Lowrie (2014).
Drosera gigantea subsp. *geniculata* N.G.Marchant & Lowrie	*Drosera geniculata* N.G.Marchant & Lowrie) Lowrie		Nomenclatural synonym. See Lowrie (2014).
Drosera gigantea Lindl. subsp. *gigantea*	*Drosera gigantea* Lindl.		Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera lanata K.Kondo	n/a		Excluded taxon. See Lowrie (2013b).
Drosera macrantha subsp. *eremaea* N.G.Marchant & Lowrie	*Drosera eremaea* (N.G.Marchant & Lowrie) Lowrie & Conran	P1	Nomenclatural synonym. See Lowrie (2014).
Drosera macrantha Endl. subsp. *macrantha*	*Drosera macrantha* Endl.		Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera macrophylla Lindl. subsp. *macrophylla*	*Drosera macrophylla* Lindl.		Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera macrophylla subsp. *monantha* Lowrie & Carlquist	*Drosera monantha* (Lowrie & Carlquist) Lowrie		Nomenclatural synonym. See Lowrie (2014).
Drosera marchantii DeBuhr subsp. *marchantii*	*Drosera marchantii* DeBuhr		Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera marchantii subsp. *prophylla* N.G.Marchant & Lowrie	*Drosera prophylla* (N.G.Marchant & Lowrie) Lowrie	P3	Nomenclatural synonym. See Lowrie (2014).

Old Name	New Name	Status	Comments
Drosera menziesii subsp. *basifolia* N.G.Marchant & Lowrie	*Drosera basifolia* (N.G.Marchant & Lowrie) Lowrie		Nomenclatural synonym. See Lowrie (2014).
Drosera menziesii DC. subsp. *menziesii*	*Drosera menziesii* DC.		Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera menziesii subsp. *penicillaris* (Benth.) N.G.Marchant & Lowrie	*Drosera drummondii* Planch.		Taxonomic synonym. See Lowrie (2014).
Drosera menziesii subsp. *thysanosepala* (Diels) N.G.Marchant	*Drosera thysanosepala* Diels		Nomenclatural synonym. See Lowrie (2014).
Drosera neesii subsp. *borealis* N.G.Marchant	*Drosera neesii* Lehm.		Taxonomic synonym. No subspecies recognised. See Lowrie (2014).
Drosera neesii Lehm. subsp. *neesii*	*Drosera neesii* Lehm.		Nomenclatural synonym. No subspecies recognised. See Lowrie (2014).
Drosera occidentalis subsp. *australis* N.G.Marchant & Lowrie	*Drosera australis* (N.G.Marchant & Lowrie) Lowrie & Conran		Nomenclatural synonym. See Lowrie (2014).
Drosera occidentalis Morrison subsp. *occidentalis*	*Drosera occidentalis* Morrison	P4	Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera paleacea DC. subsp. *paleacea*	*Drosera paleacea* DC.	P1	Nomenclatural synonym. No subspecies recognised. See Lowrie (2013b).
Drosera paleacea subsp. *trichocaulis* (Diels) N.G.Marchant & Lowrie	*Drosera trichocaulis* (Diels) Lowrie & Conran		Nomenclatural synonym. See Lowrie (2014).
Drosera parvula Planch.	*Drosera paleacea* DC.	P1	Taxonomic synonym. See Lowrie (2014).
Drosera petiolaris DC.	n/a		Excluded taxon. See Lowrie (2013b).
Elythranthera × *intermedia* (Fitzg.) M.A.Clem.	*Caladenia* × *intermedia* (Fitzg.) M.A.Clem. & D.L.Jones	P1	Nomenclatural synonym. See Jones & Clements (2017).
Eremophila glabra subsp. green flowers (E.A. Griffin 5347)	*Eremophila glabra* subsp. *chlorella* (Gand.) Chinnock	T	Name synonymised. A.P. Brown *in sched.* (02/08/2013).
Eremophila sp. Narrow leaves (J.D. Start D12-150)	*Eremophila subangustifolia* A.P.Br. & T.M.Llorens	T	Taxon formally published. See Brown *et al.* (2018).
Eucalyptus brachycorys Blakely	*Eucalyptus comitae-vallis* Maiden		Taxonomic synonym. See French (2012).
Eucalyptus capillosa Brooker & Hopper subsp. *capillosa*	*Eucalyptus capillosa* Brooker & Hopper		Nomenclatural synonym. No subspecies recognised. See French (2012).
Eucalyptus capillosa subsp. *polyclada* Brooker & Hopper	*Eucalyptus capillosa* Brooker & Hopper		Taxonomic synonym. See French (2012).
Eucalyptus sp. Wagerup (L. Johnson 9127 & B. Briggs)	*Eucalyptus* × *graniticola* Hopper	P4	Taxon formally published. See Hopper (2018).
Fioria vitifolia (L.) Mattei	*Hibiscus vitifolius* L.		Nomenclatural synonym. See Mabberley (2008).
Flemingia involucrata Benth.	*Flemingia trifoliata* (Jungh.) C.Y.Wu		Nomenclatural synonym. See van der Maesen (2012).

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Glochidion perakense Hook.f.	*Glochidion sumatranum* Miq.		Misapplied name. M.D. Barrett *in litt* (14/12/2017).
Glochidion perakense var. *supra-axillare* (Benth.) Airy Shaw	*Glochidion sumatranum* Miq.		Misapplied name. M.D. Barrett *in litt.* (14/12/2017).
Hemiarrhena plantaginea (F.Muell.) Benth.	*Lindernia plantaginea* (F.Muell.) F.Muell.		Nomenclatural synonym. See Barker (2018).
Hibbertia sp. Geraldton Sandplains (R. Edmiston E 421)	*Hibbertia squarrosa* K.R.Thiele		Taxon formally published. See Thiele (2018).
Hydrocotyle sp. Coorowensis (P.G. Wilson 12580)	*Hydrocotyle spinulifera* A.J.Perkins	P3	Taxon formally published. See Perkins (2018a).
Hydrocotyle sp. Coraginaensis (K.R. Newbey 7477)	*Hydrocotyle perforata* A.J.Perkins	P2	Taxon formally published. See Perkins (2018b).
Hydrocotyle sp. Hexaptera (T. Erickson TEE 173)	*Hydrocotyle decorata* A.J.Perkins	P2	Taxon formally published. See Perkins (2018b).
Hydrocotyle sp. Truslove (M.A. Burgman 4419)	*Hydrocotyle asterocarpa* A.J.Perkins	P2	Taxon formally published. See Perkins (2018b).
Hydrocotyle sp. Warriedar (P.G. Wilson 12267)	*Hydrocotyle dimorphocarpa* A.J.Perkins	P1	Taxon formally published. See Perkins (2018a).
Hypoxis sp. Prince Regent River (M.D. Barrett 924 B)	*Hypoxis cavernicola* M.D.Barrett	P2	Taxon formally published. See Barrett (2018).
Jacquemontia sp. Keep River (J.L. Egan 5051)	*Jacquemontia* sp. Keep River (J.L. Egan 5015)	P1	Name synonymised. See CHAH (2006).
Josephinia sp. Marandoo (M.E. Trudgen 1554)	*Josephinia eugeniae* F.Muell.		Name synonymised. W.R. Barker *in sched.* (06/04/2018).
Lasiopetalum sp. Badgingarra (E.A. Griffin 5278)	*Lasiopetalum decoratum* K.A.Sheph. & C.F.Wilkins	P2	Taxon formally published. See Shepherd & Wilkins (2018b).
Lasiopetalum sp. Hill River (T.N. Stoate 5)	*Lasiopetalum rupicola* K.A.Sheph. & C.F.Wilkins	P1	Taxon formally published. See Shepherd & Wilkins (2018b).
Lasiopetalum sp. Kukerin (C.A. Gardner 13646)	*Lasiopetalum rosmarinifolium* (Turcz.) Benth.		Name synonymised. See Shepherd & Wilkins (2018c).
Lepilaena australis Harv.	*Althenia australis* (Harv.) F.Muell.		Nomenclatural synonym. See Ito *et al.* (2016).
Lepilaena bilocularis Kirk	*Althenia bilocularis* (Kirk) Cockayne		Nomenclatural synonym. See Ito *et al.* (2016).
Lepilaena cylindrocarpa (Müll.Berol.) Benth.	*Althenia cylindrocarpa* (Müll.Berol.) Asch.		Nomenclatural synonym. See Ito *et al.* (2016).
Lepilaena marina E.L.Robertson	*Althenia marina* (E.L.Robertson) Yu Ito		Nomenclatural synonym. See Ito *et al.* (2016).
Lepilaena patentifolia E.L.Robertson	*Althenia patentifolia* (E.L.Robertson) T.Macfarlane & D.D.Sokoloff		Nomenclatural synonym. See Macfarlane *et al.* (2017).
Lepilaena preissii (Lehm.) F.Muell.	*Althenia preissii* (Lehm.) F.Muell.		Nomenclatural synonym. See Ito *et al.* (2016).
Lepilaena sp. Wheatbelt (M.T. Collins et al. 265)	*Althenia hearnii* T.Macfarlane & D.D.Sokoloff		Taxon formally published. See Macfarlane *et al.* (2017).
Leucopogon brevicuspis Benth.	*Styphelia* sp. Cascades (R. Davis 11037)		Misapplied name. M. Hislop *in litt.* (29/03/2018).

Old Name	New Name	Status	Comments
Leucopogon crassifolius Sond.	*Styphelia* sp. South Coast (J.M. Powell 3374)		Misapplied name. M. Hislop *in litt.* (29/03/2018).
Leucopogon ovalifolius Sond.	*Styphelia* sp. Albany (M. Hislop 2218)		Misapplied name. M. Hislop *in litt.* (29/03/2018).
Lindernia crustacea (L.) F.Muell.	*Torenia crustacea* (L.) Cham. & Schltdl.	*	Nomenclatural synonym. W.R. Barker *in sched.* (06/04/2018).
Lindernia subulata R.Br.	n/a		Excluded taxon. M.D. Barrett *in litt.* (03/09/2018).
Lipocarpha chinensis (Osbeck) J.Kern	*Cyperus albescens* (Steud.) Larridon & Govaerts	P3	Taxonomic synonym. See Larridon *et al.* (2016).
Meiogyne cylindrocarpa (Burck) Heusden subsp. *cylindrocarpa*	*Meiogyne cylindrocarpa* (Burck) Heusden		Nomenclatural synonym. No subspecies recognised. See Xue *et al.* (2014).
Merremia aegyptia (L.) Urb.	*Distimake aegyptius* (L.) A.R.Simões & Staples	*	Nomenclatural synonym. See Simões & Staples (2017).
Merremia dissecta (Jacq.) Hallier f.	*Distimake dissectus* (Jacq.) A.R.Simões & Staples	*	Nomenclatural synonym. See Simões & Staples (2017).
Merremia dissecta (Jacq.) Hallier f. var. *dissecta*	*Distimake dissectus* (Jacq.) A.R.Simões & Staples var. *dissectus*	*	Nomenclatural synonym. See Petrongari *et al.* (2018).
Merremia kimberleyensis R.W.Johnson	*Distimake kimberleyensis* (R.W.Johnson) A.R.Simões & Staples		Nomenclatural synonym. See Simões & Staples (2017).
Merremia quinata (R.Br.) Ooststr.	*Distimake quinatus* (R.Br.) A.R.Simões & Staples		Nomenclatural synonym. See Simões & Staples (2017).
Merremia umbellata (L.) Hallier f.	n/a		Excluded taxon. See Simões & Staples (2017).
Merremia umbellata subsp. *orientalis* (Hallier f.) Ooststr.	*Camonea pilosa* (Houtt.) A.R.Simões & Staples	P1	Misapplied name. See Simões & Staples (2017).
Mnesithea granularis (L.) de Koning & Sosef	*Hackelochloa granularis* (L.) Kuntze		Nomenclatural synonym. See Arthan *et al.* (2016).
Monochoria cyanea (F.Muell.) F.Muell.	*Pontederia cyanea* (F.Muell.) M.Pell. & C.N.Horn		Nomenclatural synonym. See Pellegrini *et al.* (2018).
Monochoria vaginalis (Burm.f.) Kunth	*Pontederia vaginalis* Burm.f.		Nomenclatural synonym. See Pellegrini *et al.* (2018).
Monodia stipoides S.W.L.Jacobs	*Triodia stipoides* (S.W.L.Jacobs) Crisp & Mant		Nomenclatural synonym. See Crisp *et al.* (2015).
Opercularia rubioides Juss.	*Opercularia nubicola* A.S.Markey	P2	Misapplied name. See Markey (2018).
Opercularia sp. Stirling Range (M. Hislop 2839)	*Opercularia nubicola* A.S.Markey	P2	Taxon formally published. See Markey (2018).
Ozothamnus sp. Filifolius (A.S. George 8292)	*Ozothamnus filifolius* Puttock		Name synonymised. See Schmidt-Lebuhn *et al.* (2018).
Ozothamnus sp. Northampton (J. Brooker & M. Weir 913)	*Ozothamnus vespertinus* R.W.Davis, Wege & Schmidt-Leb.	P1	Taxon formally published. See Schmidt-Lebuhn *et al.* (2018).
Paracaleana sp. Israelite Bay (W. Jackson 8/11/1995)	*Paracaleana parvula* Hopper & A.P.Br.	P2	Name synonymised. See Hopper & Brown (2006).

Old Name	New Name	Status	Comments
Parentucellia viscosa (L.) Caruel	*Bellardia viscosa* (L.) Fisch. & C.A.Mey.	*	Nomenclatural synonym. See Uribe-Convers & Tank (2016).
Polymeria sp. A Kimberley Flora (T.E.H. Aplin et al. 418)	*Polymeria quadrivalvis* R.Br.		Name synonymised. D.A. Halford *in litt.* (17/10/2018).
Pomax sp. desert (A.S. George 11968)	*Pomax* sp. Sand dunes (P.G. Wilson 752)		Name synonymised. G.J. Keighery *in litt.* (08/06/2015).
Pontederia cordata L.	n/a		Excluded taxon. G.J. Keighery *in litt.* (02/10/2018).
Pterostylis sp. Cape Arid (G. Brockman GBB 263)	*Pterostylis meridionalis* (D.L.Jones & C.J.French) D.L.Jones & C.J.French		Name synonymised. G.B. Brockman & C.J. French *in sched.* (18/04/2018).
Pterostylis sp. cauline leaves (N. Gibson & M.N. Lyons 1490)	*Pterostylis pyramidalis* Lindl.		Name synonymised. G.B. Brockman & C.J. French *in sched.* (18/04/2018).
Pterostylis sp. granite (W. Jackson BJ351)	*Pterostylis microphylla* D.L.Jones & C.J.French		Name synonymised. A.P. Brown *in sched.* (23/05/2018).
Pterostylis sp. Helena River (G. Brockman GBB 340)	*Pterostylis angulata* (D.L.Jones & C.J.French) D.L.Jones & C.J.French		Name synonymised. G.B. Brockman & C.J. French *in sched.* (18/04/2018).
Ptilotus gaudichaudii subsp. *eremita* (S.Moore) Lally	*Ptilotus eremita* (S.Moore) T.Hammer & R.W.Davis		Nomenclatural synonym. See Hammer *et al.* (2018a).
Ptilotus gaudichaudii (Steud.) J.M.Black subsp. *gaudichaudii*	*Ptilotus gaudichaudii* (Steud.) J.M.Black		Nomenclatural synonym. No subspecies recognised. See Hammer *et al.* (2018a).
Ptilotus nobilis (Lindl.) F.Muell. subsp. *nobilis*	*Ptilotus nobilis* (Lindl.) F.Muell.		Nomenclatural synonym. No subspecies recognised. See Hammer *et al.* (2018b).
Ptilotus petiolatus Farmar	*Ptilotus murrayi* F.Muell.		Taxonomic synonym. See Hammer (2018).
Ptilotus sp. Doolgunna (D. Edinger 4419)	*Ptilotus actinocladus* T.Hammer & R.W.Davis	P1	Taxon formally published. See Hammer & Davis (2018).
Ptilotus sp. Edaggee Station (T.E.H. Aplin 3208)	*Ptilotus unguiculatus* T.Hammer	P1	Taxon formally published. See Hammer (2018).
Ptilotus sp. Goldfields (R. Davis 10796)	*Ptilotus exaltatus* Nees		Name synonymised. See Hammer *et al.* (2018b).
Rhyncharrhena linearis (Decne.) K.L.Wilson	*Vincetoxicum lineare* (Decne.) Meve & Liede		Nomenclatural synonym. See Liede-Schumann & Meve (2018).
Sansevieria trifasciata Prain	*Dracaena trifasciata* (Prain) Mabb.	*	Nomenclatural synonym. See Mabberley (2017).
Schinus terebinthifolius Raddi	*Schinus terebinthifolia* Raddi	*	Orthographic variant. See Zona (2015).
Secamone timoriensis Decne.	*Secamone timorensis* Decne.		Orthographic variant. See Decaisne (1844).
Sida sp. verrucose glands (F.H. Mollemans 2423)	*Sida* sp. L (A.M. Ashby 4202)		Name synonymised. R.M. Barker pers. comm. (2017).

Old Name	New Name	Status	Comments
Sisyrinchium exile E.P.Bicknell	*Sisyrinchium rosulatum* E.P.Bicknell	*	Taxonomic synonym. See USDA (2018).
Spartothamnella teucriiflora (F.Muell.) Moldenke	*Teucrium teucriiflorum* (F.Muell.) Kattari & Salmaki		Nomenclatural synonym. See Salmaki *et al.* (2016).
Tecticornia sp. Little Sandy Desert (K.A. Shepherd & C. Wilkins KS 830)	*Tecticornia willisii* K.A.Sheph.	P1	Taxon formally published. See Shepherd (2018).
Tephrosia sp. C Kimberley Flora (K.F. Kenneally 5599)	*Tephrosia pedleyi* R.Butcher	P3	Taxon formally published. See Butcher (2018).
Thespesia thespesioides (Benth.) Fryxell	*Azanza thespesioides* (Benth.) F.Areces		Nomenclatural synonym. See Areces-Berazain & Ackerman (2016).
Thomasia sp. Merredin (M.B. Mills 11)	*Thomasia sarotes* Turcz.		Name synonymised. K.A. Shepherd & C.F. Wilkins *in litt.* (28/11/2018).
Thomasia sp. Salmon Gums (C.A. Gardner s.n. PERTH 02708639)	*Thomasia sarotes* Turcz.		Name synonymised. K.A. Shepherd & C.F. Wilkins *in litt.* (28/11/2018).
Thomasia sp. Toolbrunup (G.J. Keighery 9895)	*Thomasia brachystachys* Turcz.	P2	Name synonymised. C. Wilkins *in sched.* (26/07/2016).
Tylophora benthamii Tsiang	*Vincetoxicum polyanthum* Kuntze	P1	Nomenclatural synonym. See Liede-Schumann & Meve (2018).
Tylophora cinerascens (R.Br.) P.I.Forst.	*Vincetoxicum cinerascens* (R.Br.) Meve & Liede		Nomenclatural synonym. See Liede-Schumann & Meve (2018).
Tylophora flexuosa R.Br.	*Vincetoxicum flexuosum* (R.Br.) Kuntze		Nomenclatural synonym. See Liede-Schumann & Meve (2018).
Utricularia sp. Theda (M.D. Barrett MDB 2056)	*Utricularia hamata* R.W.Jobson & M.D.Barrett	P1	Taxon formally published. See Jobson *et al.* (2018).
Vaccaria hispanica (Mill.) Rauschert	*Gypsophila vaccaria* (L.) Sm.	*	Taxonomic synonym. See Madhani *et al.* (2017).
Wahlenbergia communis Carolin	*Wahlenbergia capillaris* (G.Lodd.) G.Don		Taxonomic synonym. See Turner (2016).
Zygophyllum ammophilum F.Muell.	*Roepera ammophila* (F.Muell.) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum angustifolium H.Eichler	*Roepera angustifolia* (H.Eichler) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum apiculatum F.Muell.	*Roepera apiculata* (F.Muell.) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum aurantiacum (Lindl.) F.Muell.	*Roepera aurantiaca* Lindl.		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum aurantiacum (Lindl.) F.Muell. subsp. *aurantiacum*	*Roepera aurantiaca* Lindl. subsp. *aurantiaca*		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum billardierei DC.	*Roepera billardierei* (DC.) G.Don		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum compressum J.M.Black	*Roepera compressa* (J.M.Black) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum eichleri R.M.Barker	*Roepera eichleri* (R.M.Barker) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).

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Zygophyllum eremaeum (Diels) Ostenf.	*Roepera eremaea* (Diels) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum fruticulosum DC.	*Roepera fruticulosa* (DC.) G.Don		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum glaucum F.Muell.	*Roepera glauca* (F.Muell.) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum halophilum R.M.Barker	*Roepera halophila* (R.M.Barker) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum iodocarpum F.Muell.	*Roepera iodocarpa* (F.Muell.) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum kochii Tate	*Roepera kochii* (Tate) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum lobulatum (Benth.) R.M.Barker	*Roepera lobulata* (Benth.) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum ovatum Ewart & Jean White	*Roepera ovata* (Ewart & Jean White) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum reticulatum R.M.Barker	*Roepera reticulata* (R.M.Barker) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum retivalve Domin	*Roepera retivalvis* (Domin) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum simile H.Eichler	*Roepera similis* (H.Eichler) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum tesquorum J.M.Black	*Roepera tesquorum* (J.M.Black) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).
Zygophyllum tetrapterum R.M.Barker	*Roepera tetraptera* (R.M.Barker) Beier & Thulin		Nomenclatural synonym. See Beier *et al.* (2003).

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SHORT COMMUNICATION

Acacia corusca (Fabaceae: Mimosoideae), a new species from the Pilbara bioregion in north-western Australia

Acacia corusca J.P.Bull, S.J.Dillon & Brearley, *sp. nov.*

Type: *c*. 35 km east-northeast of Newman, Western Australia [precise locality withheld for conservation reasons], 26 April 2014, *J. Bull & D. Roberts* ONS A 27.01 (*holo*: PERTH 08612277; *iso*: CANB).

Acacia sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au [accessed 13 February 2019].

Rounded to broadly rounded, robust, multi-stemmed *shrub* or *small tree* 1.5–4.0(–5.0) m high, 1.5–5.0(–6.0) m wide. *Bark* grey to dark grey, smooth except longitudinally fissured and fibrous towards the base of mature stems. *Branchlets* terete, slightly angular at extremities, youngest branchlets ribbed, with a dense indumentum of appressed, flattened, pale yellow to white, simple hairs and scattered, red-brown, glandular hairs between the ribs, and a dense indumentum of red-brown, glandular hairs on the ribs, a moderately thick layer of yellow, translucent resin often obscuring the indumentum, both the resin and indumentum becoming absent with age. *New shoots* resinous, the young phyllodes with a conspicuous marginal nerve invested with dense, red-brown, glandular hairs and the faces with a dense indumentum of pale yellow to white, appressed, flattened, simple hairs and scattered, red-brown, glandular hairs, the indumentum somewhat obscured by resin. *Stipules* triangular, red-brown, (0.4–)0.5–0.65 mm long. *Phyllodes* narrowly elliptic, narrowed at both ends, slightly kinked at the gland, (36–)38–72 mm long (occasionally interspersed with a few less than 35 mm long), 4.1–8.7 mm wide, l:w = 5.0–13.4, ascending to erect, straight to shallowly incurved or shallowly recurved, green to dark green, with a moderately dense indumentum of flattened, appressed, simple hairs and scattered red-brown glandular hairs, indumentum becoming sparser with age, slightly resinous; midrib (and sometimes 2 additional, imperfectly developed, longitudinal nerves either side of the midrib) straighter and slightly more pronounced than the minor nerves, often becoming obscure towards the phyllode apex, minor nerves numerous and anastomosing to form a dense reticulum with longitudinally elongated nerve-islands; marginal nerve pale yellow with moderately dense red-brown glandular hairs embedded in resin; apex acute to acuminate, innocuous, often shallowly recurved; pulvinus 2.0–5.3 mm long; gland on upper margin of phyllode (2.9–)3.4–13.4 mm above the pulvinus, not prominent. *Inflorescences* simple or vestigial racemes 0.5–0.8 mm long, initiated in the axils of young phyllodes; peduncles 3.0–6.2 mm long, with a sparse to moderately dense indumentum of short, appressed hairs, resinous; basal peduncular bract persistent, single, ovate, 1.0–1.4(–1.65) mm long, yellow to red-brown, with a moderately dense indumentum of appressed, simple hairs; spikes (10–)11.5–25(–27) mm long, flowers densely arranged. *Bracteoles* 0.9–1.1 mm long; claws narrowly oblong to linear, glabrous; lamina ovate, thickened proximally, ciliolate and with scattered, glandular hairs. *Flowers* 5-merous; sepals united for up to ¼ (–almost ½) of their length, 0.5–1.1 mm long, narrowly ovate, slightly expanded at the apex, sparsely papillose on margins becoming denser at apex together with simple hairs, abaxial face at apex papillose; petals 1.3–1.8(–1.9) mm long, glabrous, 1-nerved; ovary densely sericeous. *Pods* narrowly oblong, flat, scarcely raised over seeds, 17–58 mm long, 2.7–5.1 mm wide, coriaceous-crustaceous, straight, resinous but not sticky, yellow-brown to brown, with a sparse indumentum of

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appressed, white hairs, with numerous anastomosing longitudinal nerves; marginal nerve discrete, yellow. *Seeds* longitudinal in pods, obloid-ellipsoid, (3.3–)3.5–5.5(–6.0) mm long, (1.5–)1.8–3.1 mm wide, brown; areole 'u'-shaped, 0.2–0.3 mm long, 0.15–0.3 mm wide; funicle expanded into a poorly defined, once-folded, terminal aril. (Figure 1)

Diagnostic features. *Acacia corusca* can be distinguished from other Western Australian *Acacia* species by the following combination of characters: phyllodes with 1(–3) longitudinal nerves that are slightly more prominent than the minor nerves and with numerous anastomosing minor nerves that form a dense reticulum with longitudinally elongated nerve islands; a gland that is distinctly distant from the pulvinus resulting in a slight though distinct kink in the phyllode (Figure 1B); the presence of red-brown glandular hairs on new growth and along the margins of the phyllodes; cylindrical inflorescences (Figure 1C); sepals that are united for ¼(–½) the length of the calyx; narrow, firm-textured pods with anastomosing longitudinal nerves (Figure 1D).

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 July 2015, *J. Bull* ONS AEF 1 (PERTH); 16 July 2015, *J. Bull* ONS AEF 3 (PERTH); 3 Aug. 2015, *J. Bull & D. Brearley* ONS 2.4 (PERTH); 3 Aug. 2015, *J. Bull & D. Brearley* ONS 2.5 (PERTH); 25 Apr. 2014, *J. Bull & D. Roberts* ONS A 25 (PERTH); 25 Apr. 2014, *J. Bull & D. Roberts* ONS A 57 (PERTH); 27 Apr. 2014, *J. Bull & D. Roberts* ONS A 100 (PERTH); 8 July 2014, *J. Bull & D. Roberts* ONS S 71 (PERTH); 10 July 2014, *J. Bull & D. Roberts* ONS S 107 (PERTH); 13 Sep. 2014, *J. Bull & D. Roberts* ONS R 25 (PERTH); 13 Sep. 2014, *J. Bull & D. Roberts* ONS R 28 (PERTH).

Phenology. Flowering has been observed from mid-autumn to late winter (April to August), and fruiting from late winter to mid-spring (August to October). Like many arid dwelling *Acacia* species, *A. corusca* appears to set fruit in response to adequate winter rainfall (Preece 1971; Mangadas & Fox 2002) but further study is required to confirm this.

Distribution and habitat. *Acacia corusca* occurs east-northeast of the town of Newman in the southeast Pilbara bioregion of Western Australia. A total of 567 plants have been recorded from three populations covering approximately 8.1 hectares (Onshore Environmental 2014, 2015a). Extensive targeted surveys of the surrounding region were undertaken but no further populations were located (Onshore Environmental 2015a, 2015b). *Acacia corusca* grows in red-brown sandy-loam soils on hill crests, ridges, slopes and minor drainage lines upon low, subdued and undulating stony hills. It rarely grows on hill summits and the largest populations appear to prefer exposed hill ridges, outcrops and rocky hill slopes composed of Boolgeeda Iron Formation overlying Woongarra Rhyolite (Figure 1A). Associated vegetation is typically spinifex hummock grassland of *Triodia pungens* and *Triodia vanleeuwenii* with scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia*, *Acacia aptaneura* and *Grevillea berryana*, open shrublands of *Grevillea wickhamii* subsp. *hispidula*, *Senna glutinosa* and *Acacia marramamba* and scattered tussock grasses of *Eriachne mucronata* and *Cymbopogon ambiguus*.

Conservation status. *Acacia corusca* is listed as Priority One under Conservation Codes for Western Australian Flora (Smith & Jones 2018), as *Acacia* sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01).

Etymology. The epithet is from the Latin *corusco* (to flash, glitter or shimmer), in reference to the shimmering effect of the dark green foliage on windy days. This character was valuable in locating populations of *Acacia corusca* from a distance, especially on typically exposed hill slopes.

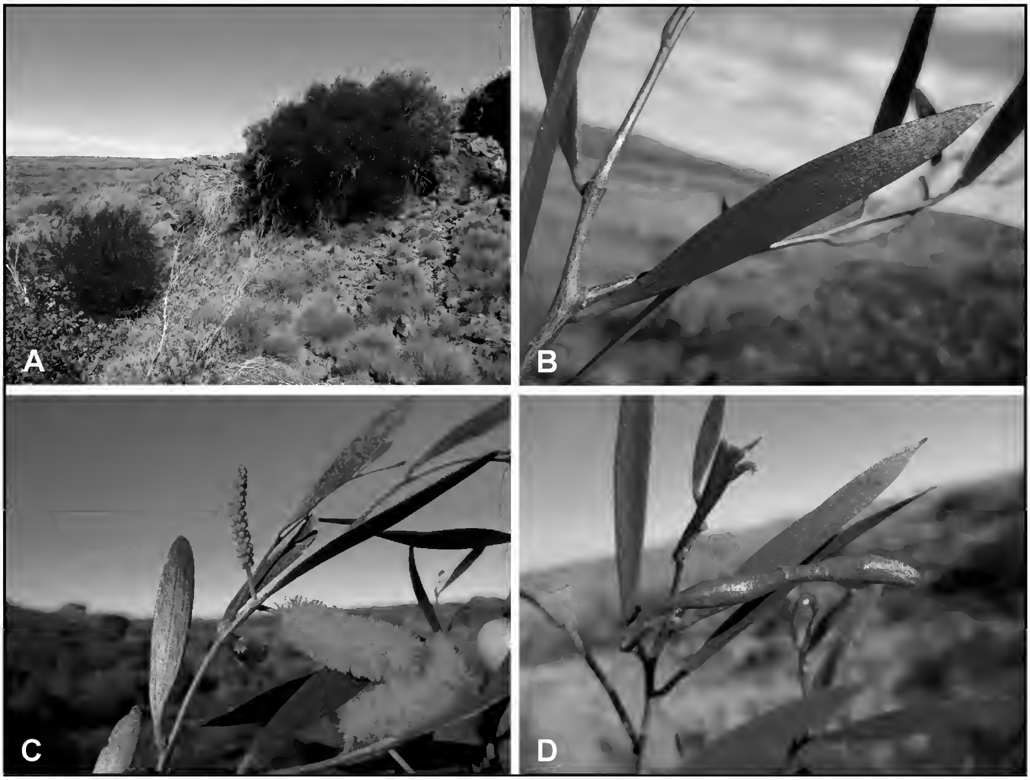

Figure 1. *Acacia corusca*. A – habit and habitat; B – branches showing ascending phyllodes with longitudinal reticulation and gland on adaxial edge; C – upper branch with both immature and mature cylindrical flowering spikes; D – immature pod with two seeds. Image from *J. Bull & D. Roberts* ONS R 28 (PERTH) (D). Photographs by Jerome Bull.

Affinities. *Acacia corusca* appears to have affinities with *A. melleodora* Pedley and *A. dictyophleba* F.Muell, both of which also occur in the Pilbara. These taxa are similar to *A. corusca* in that they are rounded shrubs, have a phyllode nervature pattern comprising a dense reticulum of anastomosing nerves and have funicles with a poorly defined aril. However, both *A. melleodora* and *A. dictyophleba* differ significantly from *A. corusca* in that they are glabrous; have phyllodes with a rounded apex, a gland positioned adjacent to the apical mucro and an open and net-like reticulum (rather than longitudinally elongated); globular inflorescences; sepals that are united almost to the apex; flat, papery pods; and have seeds with a larger areole (1.1–1.5 mm wide) that are transversely arranged in the pods.

Common name. Shimmer Wattle.

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SHORT COMMUNICATION

Gastrolobium sp. Harvey (G.J. Keighery 16821) (Fabaceae) is not distinct from *G. capitatum*

The phrase-name *Gastrolobium* sp. Harvey (G.J. Keighery 16821) was placed on the Western Australian plant census in 2006 following the collection of three specimens (*G.J. Keighery* 16715, 16788 & 16821) in 2005 from two small wetland reserves in the Pinjarra–Harvey area. It was given a Priority Two conservation listing in 2008 based on its restricted distribution and potential threats to habitat posed by the construction of the Perth–Bunbury Highway, a conservation status it still retains (Smith & Jones 2018).

In the absence of contemporary documentation detailing the morphological basis for its recognition, it is not known with what species *G.* sp. Harvey was compared in order to determine that it was distinct. We suspect a comparison was made with *G. ebracteolatum* G.Chandler & Crisp, under which all three specimens were originally placed, presumably because of a shared wetland habitat, similar long, narrow, often alternate leaves and a tall habit (variously recorded in the three specimens as 'sprawling shrub 2 m tall × 2 m wide', 'twining erect shrub 2 m tall × 2 m wide' and 'slender erect scrambling shrub 1–2 m tall × 2 m wide'). There are, however, some major differences between the two, with *G.* sp. Harvey having condensed axillary or terminal racemes (inflorescences 2–6-flowered; rachis 1–3 mm long) rather than elongate terminal racemes (inflorescences at least 20-flowered; rachis 60–180 mm long), and four to eight ovules rather than at least 15 (Chandler *et al.* 2002).

Examination of the *Gastrolobium* R.Br. collection at the Western Australian Herbarium (PERTH) has since found that *G.* sp. Harvey is comparable in its floral and foliar morphology to a large number of *G. capitatum* (Benth.) G.Chandler & Crisp specimens. In particular, specimens referred to as a 'narrow leafed form, generally recumbent, typically on/around swamps of the Swan Coastal Plain' (E.A. Griffin 1993, *in sched.*) match *G.* sp. Harvey in all features other than the size of the plants (*G. capitatum* is typically a sprawling sub-shrub to 1 m tall). Two 'Swan Coastal Plain Survey' (Gibson *et al.* 1994) voucher specimens collected from seasonally wet sites and identified as *Gastrolobium* aff. *capitatum* (originally as *Nemcia* aff. *capitata*; *B.J. Keighery & N. Gibson* 120 & 132) also match Griffin's concept of this swamp form. Chandler *et al.* (2002: 679) noted that *G. capitatum* 'grows in a variety of habitats, from wet to quite dry, on sandy to loamy soils in woodland or open forest' but did not recognise any ecotypes as warranting formal taxonomic status. It is noteworthy that their specimen citations under *G. capitatum* included *B.J. Keighery & N. Gibson* 120.

Relative to plants collected from drier habitats there is a tendency for wetland specimens of *G. capitatum* to have leaves that are narrower and for there to be a higher ratio of alternate to opposite leaves (note that a mixed phyllotaxis is the norm for this species). However, these are tendencies only and neither constitutes a consistent difference. The following specimens exemplify the overlapping nature of these characters: *S. Turner* 257 and *S. Turner* 310, from dry *Banksia* woodland in metropolitan Kiara and Noranda, respectively, have the narrow leaves (to 5 mm) typical of the wetland variant but with opposite leaves predominating; *M.D.Crisp & W.M. Keys* MDC 8943, from a wetland in the Busselton area, has mostly alternate leaves but their width (to 8 mm) is more commonly found in plants growing in dry habitats; *M.J. Kealley* 1304, from the Darling Range north-west of Bannister, has narrow, mostly alternate leaves but is from a dry, lateritic site.

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Examination of specimens of *G.* sp. Harvey against the *G. capitatum* collection at PERTH cannot identify any morphological characters by which this entity might be considered distinct. The narrow leaf form and predominantly alternate phyllotaxis characteristic of *G.* sp. Harvey is shared with most *G. capitatum* specimens collected from seasonally wet areas (as well as some collected from drier habitats). Both phyllotaxis and leaf size must be regarded as variable characters in this species.

The only feature of *G.* sp. Harvey that falls outside the known parameters of *G. capitatum* is plant size. The recorded dimensions of up to 2 m high and 2 m wide are certainly well beyond the proportions otherwise recorded for *G. capitatum*. Perhaps the habitat at these sites is particularly favourable to the species or the areas are long-unburnt, or both, but even if the reasons for the large growth habit are genetic, a single difference of this kind does not provide a strong basis for the recognition of a distinct taxon. In summary therefore, we believe that *G.* sp. Harvey is best regarded as a variant or ecotype of *G. capitatum*.

Taxonomic investigation of this phrase-name has also identified that the key to species of *Gastrolobium* (Chandler *et al.* 2002) contains contradictory information to that presented in species descriptions, such that good representatives of a species may not key out correctly. For example, lead 114 (Chandler *et al.* 2002: 627) provides the alternatives ‘rachis >5 mm long’ and ‘rachis <1 mm long’, but *G. capitatum*, which is recorded as having ‘rachis 1–2 mm long’ in its description (Chandler *et al.* 2002: 678), falls into neither category and can only be reached in the key if the first alternative is taken. Problems with the key may have contributed to the original misidentification of the three specimens that later became the basis for the phrase name *G.* sp. Harvey, which highlights the importance of a well-curated research herbarium collection for accurate species identification.

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SHORT COMMUNICATION

Eremophila oldfieldii subsp. *papula*, *E. sericea* and *E. xantholaema* (Scrophulariaceae), three new taxa from Western Australia

Eremophila oldfieldii F.Muell. subsp. **papula** A.P.Br., *subsp. nov.*

Type: Karara, Western Australia [precise locality withheld for conservation reasons], 22 September 2017, *A.P. Brown & R.W. Davis* APB 4307 (*holo*: PERTH 09033971; *iso*: AD, CANB, MEL).

Eremophila oldfieldii subsp. Karara (D. Coultas s.n. PERTH 07341717), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed October 2018].

Illustration. A.P. Brown & B.J. Buirchell, *A Field Guide to the Eremophilas of W. Austral.*, p. 197 (2011), as *E. oldfieldii* subsp. Karara.

An erect to spreading much branched *shrub* 1.5–3.0 m high, 2–4 m wide. *Branches* grey, terete, tuberculate, young parts with sparse grey-white branched hairs, old parts glabrescent. *Leaves* green to grey-green, sessile, although gradually tapering to a short petiole-like base, alternate, erect or spreading, scattered along branches, oblanceolate, (20–)40–55(–65) mm long, (6–)7–10(–12) mm wide, the upper and lower surfaces glandular-pustulate; apex acute to subobtuse; margins entire. *Flowers* 1 per axil; pedicel terete basally, becoming dilated distally, straight or slightly curved, 10–15 mm long, with scattered, grey-white branched hairs. *Sepals* 5, oblanceolate, attenuate, imbricate towards the base, equal or subequal, 12–18 mm long, 4–8 mm wide, not enlarging after flowering; outer and inner surfaces green, sometimes tinged with brown, with sparse short simple hairs. *Corolla* zygomorphic, 22–30 mm long, 8–10 mm wide; outer and inner surfaces orange-red to brick red, unspotted, glabrous with the exception of scattered simple hairs along the margins of lobes; lowermost lobe dilated, truncate to emarginate; upper 4 lobes acute. *Stamens* 4, exserted; filaments 25–30 mm long, glabrous; anthers glabrous. *Ovary* ovoid, 4-locular with 2 ovules per locule, 3–4 mm long, 2.0–2.5 mm wide, glabrous or with sparse short simple hairs. *Style* 25–30 mm long, glabrous. *Fruit* dry, subglobular, 7–9 mm long, 4–5 mm wide, rugose, glabrous. *Seed* ovoid, 2.2–2.4 mm long, 1–1.2 mm wide. (Figure 1)

Diagnostic features. *Eremophila oldfieldii* subsp. *papula* may be distinguished from other subspecies of *E. oldfieldii* F.Muell. by its glandular-pustulate leaves and the following combination of characters: branches tuberculate; leaves oblanceolate, 40–55 × 7–10 mm.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 Nov. 2005, *D. Coultas s.n.* (PERTH); 22 Sep. 2010, *D. Coultas & A. Saligari* DCAS Opp 9 (PERTH); 14 Nov. 2015, *A. Crawford* ADC 2686 (PERTH); 29 Sep. 2010, *K. Greenacre & B. Stratton*, KIOP 145-01 (PERTH).

Phenology. Predominantly flowers from August to November with rare flowering following rainfall at other times of the year. Fruiting throughout the year following flowering.

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Figure 1. *Eremophila oldfieldii* subsp. *papula*. A – flowering plant *in situ* showing a much branched, spreading habit; B – flower, showing the large oblanceolate, attenuate sepals and unspotted, subglabrous corolla; C – leaves, showing the characteristic glandular-pustulate upper and lower surfaces of the lamina. Images from *A.P. Brown* & *R.W.* Davis APB 4307. Photographs by A.P. Brown.

Distribution and habitat. Found over a small geographic range north-east of Perenjori in the Yalgoo bioregion (*sensu* Department of the Environment 2017), growing in red brown clay loam on the lower slopes of rocky hills. Associated species include *Acacia tetragonophylla*, *Eucalyptus loxophleba* subsp. *supralaevis*, *Exocarpos aphyllus*, *Tecticornia pterygosperma* subsp. *pterygosperma* and *Mesembryanthemum nodiflorum*.

Conservation status. Currently listed as Priority One under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *E. oldfieldii* subsp. Karara (D. Coultas s.n. PERTH 07341717). The subspecies is known from rare, scattered populations in an area that may be subject to future mining.

Etymology. From the Latin *papula* (pimple or pustule), in reference to the glandular-pustulate leaves of this subspecies.

Notes. *Eremophila oldfieldii* subsp. *papula* may be distinguished from the other two subspecies by its glandular-pustulate leaves and tuberculate branches. It also differs from subsp. *oldfieldii* in its shorter stature 1.5–3 m high when mature (*cf.* 3–6 m in subsp. *oldfieldii*) and usually shorter, broader leaves 40–55 × 7–10 mm (*cf.* 50–100 × 3–8 mm) and from subsp. *angustifolia* (S.Moore) Chinnock in its broader leaves 7–10 mm wide (*cf.* 1.5–2.5 mm in subsp. *angustifolia*).

Although *Eremophila oldfieldii* subsp. *papula* is found near *E. oldfieldii* subsp. *oldfieldii* and occurs in similar habitat, they are not known to grow together.

Eremophila sericea A.P.Br., *sp. nov.*

Type: Karara, Western Australia [precise locality withheld for conservation reasons], 22 September 2017, *A.P. Brown & R.W. Davis* APB 4308 (*holo*: PERTH 09033963; *iso*: CANB, MEL).

Eremophila sp. Rothsay (D. Coultas & J. Kelt s.n. PERTH 08200440), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed October 2018].

Illustration. A.P. Brown & B.J. Buirchell, *A Field Guide to the Eremophilas of W. Austral.*, p. 316 (2011), as *E.* sp. Rothsay.

A small much branched *shrub*, 0.2–1.2 m high, 0.8–1.6 m wide. *Branches* grey, terete, non-tuberculate, young parts with a dense indumentum of grey-white, branched hairs, old parts glabrescent. *Leaves* grey-white, more rarely grey-green, shortly petiolate, opposite, erect or spreading, scattered along branches; pedicel terete, straight or slightly curved, 2–3 mm long, with crowded, grey-white branched hairs; lamina elliptic, 15–25 mm long, 6–14 mm wide, the upper and lower surfaces with crowded, grey-white branched hairs; apex obtuse to subobtuse, margins entire. *Flowers* 2 per axil. *Sepals* 5, lanceolate, attenuate, imbricate, equal, appressed against the corolla, 5–7 mm long, 1.5–2.0 mm wide, not enlarging after flowering; outer surface grey-white, more rarely grey-green, with a dense indumentum of short, grey-white branched hairs; inner surface grey-green with short, grey-white branched hairs in distal third, more sparsely hairy below except along margins. *Corolla* zygomorphic, 17–22 mm long, 8–10 mm wide, abruptly constricting above ovary; outer surface purple to pale lilac, unspotted, with crowded grey-white branched hairs; inner surface white, with scattered villous-arachnoid hairs extending down from below medial lobe of lower lip; lobes subequal, spreading, obtuse. *Stamens* 4, included; filaments 5–8 mm long, glabrous; anthers glabrous. *Ovary* ovoid-obloid, 4-locular with 1 ovule per locule, 3–5 mm long, 2–4 mm wide, with crowded branched hairs. *Style* 6–8 mm long, glabrous. *Fruit* dry, ovoid-conical, 6–8 mm long, 5–7 mm wide, rugose, with scattered branched hairs when young. *Seed* unknown. (Figure 2)

Diagnostic features. *Eremophila sericea* may be distinguished from all other members of the genus by the following combination of characters: small much branched shrub up to 1.2 m high; branches, leaves and sepals with a dense indumentum of grey-white branched hairs; leaves shortly petiolate, opposite, lamina elliptic; flowers 2 per axil; sepals lanceolate, attenuate, imbricate, equal, appressed against the corolla; corolla purple to pale lilac, unspotted, abruptly constricting above the ovary; outer surface with crowded, grey-white branched hairs; inner surface white with scattered villous-arachnoid hairs extending down from below the medial lobe of lower lip.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 Mar. 2015, *J. Borger* PJ 04 (PERTH); 26 Oct. 2009, *D. Coultas & J. Kelt* Opp 1 (PERTH); 16 Nov. 2009, *D. Coultas & J. Kelt s.n.* (PERTH); 15 Sep. 2010, *D. Coultas & K. Greenacre* DCKG Opp 1 (PERTH); 6 Jan. 2016, *A. Crawford* ADC 2727 (PERTH).

Phenology. Predominantly flowers from September to November with rare flowering following rainfall at other times of the year. Fruiting throughout the year following flowering.

Figure 2. *Eremophila sericea*. A – flowering plant *in situ* showing the much branched habit; B – flowering stem, showing the grey-white indumentum on the stems, leaves and sepals, the opposite leaves and the purple to pale lilac, unspotted corolla; C – close up of flower. Images from *A.P. Brown* & *R.W. Davis* APB 4308. Photographs by A.P. Brown.

Distribution and habitat. Found over a small geographic range north-east Perenjori in the Avon Wheatbelt and Yalgoo bioregions (*sensu* Department of the Environment 2017), growing in red brown clay loam on the lower slopes of rocky hills. Associated species include *Acacia andrewsii*, *Eucalyptus loxophleba* subsp. *supralaevis*, *E. salubris*, *Eremophila oldfieldii* subsp. *oldfieldii*, *E. scoparia* and *Senna charlesiana*.

Conservation status. Currently listed as Priority One under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *E.* sp. Rothsay (D. Coultas & J. Kelt s.n. PERTH 08200440). The species is known from several mostly small populations. One population is on a weedy road verge and all others are in an area that may be subject to future mining.

Etymology. From the Latin *sericeus* (silky), in reference to the densely silky-hairy branches, leaves and sepals of this species.

Affinities. *Eremophila sericea* appears closest in morphology to *E. malacoides* Chinnock and like that species is a densely hairy, much branched shrub up to 1.2 m high with opposite, elliptic leaves, lanceolate, attenuate sepals and a tubular, lilac to purple corolla that is constricted just above the ovary. *Eremophila sericea* may be distinguished from *E. malacoides* by its larger leaves, 15–25 × 6–14 mm (*cf.* 5–15 × 2.5–6.0 mm in *E. malacoides*), two flowers per axil (*cf.* one flower per axil) and smaller corolla 17–22 mm long (*cf.* 20–32 mm long).

Notes. *Eremophila sericea* occasionally hybridises with *E. scoparia* (R.Br.) F.Muell., producing offspring that are intermediate in morphology, i.e. *R. Meissner & R. Coppen* 4312. However, the parent species do not appear to be closely related as they differ in their stature, leaf width, sepal length and corolla indumentum.

Eremophila xantholaema R.W.Davis, *sp. nov.*

Type: Bulong, Western Australia [precise locality withheld for conservation reasons], 16 September 2018, *R. Davis & A. Brown* RD 12904 (*holo*: PERTH 08171033; *iso*: CANB, MEL).

Eremophila sp. Kalgoorlie (V. Clarke & A. Brown VTC 590), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed October 2018].

Illustration. A.P. Brown & B.J. Buirchell, *A Field Guide to the Eremophilas of W. Austral.*, p. 298 (2011), as *E.* sp. Kalgoorlie.

Erect *shrub* to 1.2–3.0 m high, 0.9–1.3 m wide. *Branches* grey, compressed to terete, with a dense indumentum of short, appressed, flattened hairs. *Leaves* grey-green, opposite to sub-opposite; lamina linear, 25–40 mm long, 1.5–2.0 mm wide, terete to sub-terete and channelled, with crowded, appressed, flattened hairs intermixed with scattered, short glandular hairs; apex uncinate; margins entire. *Flowers* 1 per axil; pedicel straight or slightly curved, 2–3 mm long; with appressed, flattened hairs. *Sepals* 5, separated at base, sub-equal, spathulate to oblanceolate, 5–6 mm long, 1.2–2.5 mm wide, not enlarging after flowering (splaying slightly towards the apex in fruit); outer and inner surfaces mauve to pale pink, with crowded, flattened, appressed hairs, intermixed with scattered glandular hairs. *Corolla* zygomorphic, 9–12 mm long, 6.0–7.5 mm wide, outer surface pale pink and mauve, more rarely pale yellow and mauve, glabrous, inner surface below the lobes predominantly yellow with darker brown or orange markings, with densely tangled hairs in the throat; lobes mauve to pale pink, subequal,

spreading, obtuse with sparse, short hairs. *Stamens* 4, included; filaments 4.5–5.5 mm long, with crowded, simple hairs on the lower half; anthers glabrous. *Ovary* ovoid, 4-locular with one ovule per locule, 1.3–1.5 mm long, 0.8–0.9 mm wide, with crowded simple hairs. *Style* 6–6.5 mm long, with scattered, long, simple hairs on the lower two thirds. *Fruit* dry, ovoid, 2.8–3.0 mm long, 1.5–1.7 mm wide, with crowded, simple hairs. *Seed* unknown. (Figure 3)

Diagnostic features. *Eremophila xantholaema* may be distinguished from all other members of the genus by the following combination of characters: tall erect shrub up to 3 m high; sepals oblanceolate, free or fused only at the base; vegetative parts clothed in a fine pubescence of flattened, appressed hairs; corolla mauve to pale pink, 9–12 mm long, the inner surface below the lobes predominantly yellow with brown or orange markings.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 Oct. 2005, *V. Clarke & A. Brown* VTC 590 (PERTH); 16 Oct. 2005, *M.J. Grieve & J.D. Start* D7 122 (PERTH).

Phenology. Predominantly flowers from September to October with rare flowering following rainfall at other times of the year. Fruiting throughout the year following flowering.

Distribution and habitat. Found near Bulong in the Coolgardie Bioregion (*sensu* Department of the Environment 2017), growing in stony, brown loam soils in *Eucalyptus-Casuarina* woodland on the upper slopes of low rocky hills. Associated species include *Casuarina pauper*, *Eremophila glabra* subsp. *glabra*, *E. parvifolia* subsp. *auricampa*, *E. pustulata*, *Senna artemisioides* subsp. *filifolia* and *Westringia rigida*.

Figure 3. *Eremophila xantholaema*. A – plant *in situ* showing the erect habit; B – leaves and flowers showing the terete or sub-terete grey-green leaves and flowers with sub-equal sepals and glabrous corolla with markings in the throat. Images from *R.W. Davis & A.P. Brown* RD 12904 (A) and *V. Clarke & A. Brown* VTC 590 (B). Photographs by A.P. Brown.

Conservation status. Currently listed as Priority One under Conservation Codes for Western Australian Flora (Smith & Jones 2018) under the name *E.* sp. Kalgoorlie (V. Clarke & A. Brown VTC 590). The species is known from just three populations near Bulong.

Etymology. The epithet is from the Greek *xantho-* (yellow-) and *laimos* (throat), in reference to the inner surface of the corolla which is predominantly yellow with brown or orange markings.

Affinities. *Eremophila xantholaema* appears closest in morphology to *E. oppositifolia* R.Br. subsp. *angustifolia* (S.Moore) Chinnock and co-occurs with that taxon east of Kalgoorlie. *Eremophila xantholaema* may be distinguished from *E. oppositifolia* subsp. *angustifolia* by its usually shorter, sub-opposite leaves 25–40 mm long (*cf.* 29–120 mm long and opposite in *E. oppositifolia* subsp. *angustifolia*), shorter corolla 9–12 mm long (*cf.* 15–30 mm long) and the prominent yellow mottled markings in the throat of the corolla (*cf.* no markings).

Notes. *Eremophila xantholaema* was first recognised as distinct in October 2005, when plants were found near Bulong. The species has since been surveyed for over a wide area, with just two additional populations found, both within 10 km of the type location.

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An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae. 6. *Scholtzia*

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Abstract

Rye, B.L. An update to the taxonomy of the Western Australian genera of the Myrtaceae tribe Chamelaucieae. 6. *Scholtzia*. *Nuytsia* 30: 33–86 (2019). Twenty five new species and five new subspecies of *Scholtzia* are described: *S. bellairsiorum* Rye, *S. brevistylis* Rye, *S. brevistylis* subsp. *prowaka* Rye, *S. calcicola* Rye, *S. chapmanii* Trudgen ex Rye, *S. cordata* Trudgen ex Rye, *S. corrugata* Rye, *S. denticulata* Rye, *S. halophila* Rye, *S. halophila* subsp. *meridionalis* Rye, *S. halophila* subsp. *mortlockensis* Rye, *S. inaequalis* Rye, *S. laciniata* Rye, *S. longipedata* Rye, *S. longipedata* subsp. *procera* Rye, *S. multiflora* Rye, *S. oleosa* Rye, *S. peltigera* Rye, *S. pentamera* Rye, *S. pentamera* subsp. *collina* Rye, *S. prostrata* Rye, *S. quindecim* Rye, *S. recurva* Rye, *S. subsessilis* Rye, *S. tenuissima* Rye, *S. thinicola* Rye, *S. trilocularis* Rye, *S. truncata* Rye, *S. uniflora* Rye and *S. uniovulata* Rye. *Scholtzia* sp. Shark Bay (M.E. Trudgen 7429) is reduced to synonymy under *S. capitata* Benth. and most of the other phrase names in the genus are treated as synonyms of the above new taxa. A key is given to aid the identification of approximately 40 species and subspecies. Most taxa have conservation priority.

Introduction

This paper on *Scholtzia* Schauer is one of a series designed to reduce the large backlog of unnamed members of Myrtaceae tribe Chamelaucieae and draw attention to any problematic taxa. *Scholtzia* is endemic to Western Australia, extending from near Carnarvon south to near Harvey. It is the largest genus of a proposed new subtribe (Rye *et al.* in prep.) that includes *Babingtonia* Lindl., *Hysterobaeckea* (Nied.) Rye, *Malleostemon* J.W.Green and *Sannantha* Peter G.Wilson. Apart from a recent paper establishing lectotypes (Rye 2017), there has been very little published regarding the taxonomy of *Scholtzia* since Bentham's (1867) treatment of it in *Flora Australiensis*.

Background

When Schauer (1843, 1844) named *Scholtzia*, only two species, now known as *S. obovata* (DC.) Schauer and *S. involucrata* (Endl.) Druce, had been described. Schauer regarded *Scholtzia* as having axillary, dichotomously cymose inflorescences, anthers dehiscent by pores, and a 2-locular ovary with two ovules in each loculus, but was apparently unaware of the indehiscent fruit, which is one of the important characters that define the genus. He recorded 20 stamens, a common number in *S. involucrata* (see Figure 1A), although stamen numbers range from about 15 to 30 in this species.

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A third species, now known as *S. spatulata* (Turcz.) Benth., was described by Turczaninow (1862), who treated it as a new genus, *Piptandra* Turcz. This species differed from the two previously named species in having a 3-locular ovary.

Ten more names were published by Mueller (1864) and Bentham (1867), although not all of them are still considered to represent distinct species. Based on this larger number of species, Bentham (1867: 66) described the genus as having a 2- or 3-locular ovary, usually with two superposed ovules per loculus, but rarely one or three ovules per loculus. Actually, there is sometimes only one loculus and the ovule number is either one or two per loculus. Bentham also described the genus as having three kinds of fruits, valvate, indehiscent and schizocarpic, when in fact the fruits are uniformly indehiscent.

Since 1867, only one species, *S. eatoniana* (Ewart & J.R.White) C.A.Gardner, has been named; altogether 12 of the named taxa in *Scholtzia* are considered here to be good species. A flora treatment for the Perth region (Rye 1987) treated only three species. Trudgen established manuscript names for two very distinctive new species during the 1990s, one of which was listed by Paczkowska and Chapman (2000), but both were later replaced by phrase names. A total of 44 phrase names have been applied to members of the genus (Table 1).

Rye (2017) selected lectotypes for the genus and several species, and relegated two phrase names and one published name to synonymy. This left about 40 phrase names still in use prior to the current paper.

Need for further work

One of the unnamed species, *S.* sp. Geraldton (F. Lullfitz L 3216), does not match *Scholtzia* as circumscribed here, but does not appear to match any of the other named genera either (see Rye 2016: 105), so is retained under *Scholtzia* pending molecular studies to help establish its affinities.

Four of the phrase names that remain unaltered by the current study are of taxa that are considered to be too poorly collected to adequately assess and describe. These are *S.* sp. Bickley (W.H. Loaring s.n. PERTH 06165184), *S.* sp. Nolba (E. Place s.n. Jan. 1964), *S.* sp. Walebing (S. McNee 4) and *S.* sp. Whelarra (M.E. Trudgen 12018). Several others belong to three complexes that need further study to determine how many taxa should be recognised:

1. *Scholtzia involucrata* complex. This has both low-growing plants and erect ones up to 3 m tall.

2. *Scholtzia laxiflora* Benth. complex. This is variable in characters such as leaf shape and peduncle length. Mike Hislop (pers. comm.) has observed two variants that sometimes co-occur but differ in habit, flowering time and microhabitat.

3. *Scholtzia obovata* complex. This complex has the longest geographic range and includes specimens currently identified as *S. umbellifera* F.Muell.

Methods

Measurements were taken from dried material using the largest leaves and bracts, and using fully mature floral parts that were well pressed. The stigma is recorded as peltate if it is more than twice as wide as its attachment point at maturity and as capitate if it is less than twice as wide.

Table 1. Phrase names and manuscript names for taxa in *Scholtzia*, with the year each was established and its new name or a comment.

Phrase name or manuscript name	Year	Published name or comment
Scholtzia chapmanii Trudgen ms	1993	*Scholtzia chapmanii* Trudgen ex Rye
Scholtzia cordata Trudgen ms	1994	*Scholtzia cordata* Trudgen ex Rye
Scholtzia sp. Ajana (TA. Halliday 137)	1994	*Scholtzia bellairsiorum* Rye
Scholtzia sp. Ajana East Road (M.E. Trudgen 21734 A)	2006	*Scholtzia truncata* Rye
Scholtzia sp. Bickley (W.H. Loaring s.n. PERTH 06165184)	2002	known from a single collection
Scholtzia sp. Billeranga Hills (B.J. Conn 2159)	2010	*Scholtzia subsessilis* Rye
Scholtzia sp. Binnu (M.E. Trudgen 2218)	1994	*Scholtzia uniflora* Rye
Scholtzia sp. Binnu East Road (M.E. Trudgen 12013)	1995	*Scholtzia thinicola* Rye
Scholtzia sp. Binnu-Yuna (M.E. Trudgen 12016)	2003	*Scholtzia longipedata* subsp. *procera* Rye
Scholtzia sp. Bungabandi Creek (M. Quick EURA 48)	2004	*Scholtzia peltigera* Rye
Scholtzia sp. Burma Road (A.C. Burns 138)	2002	*Scholtzia prostrata* Rye
Scholtzia sp. Coburn (N. Murdock NM 031)	2018	*Scholtzia corrugata* Rye
Scholtzia sp. Coomberdale (M.E. & M.E. Trudgen MET 1724)	2006	*Scholtzia halophila* Rye subsp. *halophila*
Scholtzia sp. Dongara (R. Hart 8401)	2003	*Scholtzia calcicola* Rye
Scholtzia sp. Duck Pool (M.E. Trudgen MET 5427)	2006	*Scholtzia halophila* subsp. *mortlockensis* Rye
Scholtzia sp. East Yuna (A.C. Burns 6)	1994	*Scholtzia inaequalis* Rye
Scholtzia sp. Eneabba (S. Maley 8)	1996	*Scholtzia trilocularis* Rye
Scholtzia sp. Eradu (R.D. Royce 8016)	1994	*Scholtzia longipedata* subsp. *procera* Rye
Scholtzia sp. Eurardy (J.S. Beard 6886)	1994	*Scholtzia oleosa* Rye
Scholtzia sp. Folly Hill (M.E. Trudgen 12097)	1995	belongs to *Scholtzia obovata* (DC.) Schauer complex
Scholtzia sp. Galena (W.E. Blackall 4728)	1994	*Scholtzia truncata* Rye
Scholtzia sp. Geraldton (F. Lullfitz L 3216)	1994	atypical of the genus in ovule number
Scholtzia sp. Gunyidi (J.D. Briggs 1721)	1994	*Scholtzia quindecim* Rye
Scholtzia sp. Jurien (R.J. Cranfield & P.J. Spencer RJC 8443)	2003	belongs to *Scholtzia involucrata* (Endl.) Druce complex
Scholtzia sp. Kalbarri (N. Hoyle 623)	1996	*Scholtzia oligandra* F.Muell. ex Benth.
Scholtzia sp. Kojarina (A.M. Ashby 1904)	1994	*Scholtzia multiflora* Rye
Scholtzia sp. Lancelin (M.E. Trudgen 1516)	2003	*Scholtzia laciniata* Rye
Scholtzia sp. Murchison (M.E. Trudgen 1685)	2002	belongs to *Scholtzia laxiflora* Benth. complex
Scholtzia sp. Murchison River (A.S. George 7908)	?1994	*Scholtzia denticulata* Rye
Scholtzia sp. Nolba (E. Place s.n. Jan. 1964)	1994	known from a single collection
Scholtzia sp. Northampton (A Strid 20714)	1995	*Scholtzia pentamera* Rye subsp. *pentamera*
Scholtzia sp. Overlander (M.E. Trudgen 12138)	2018	*Scholtzia recurva* Rye
Scholtzia sp. Prowaka Springs (R.J. Cranfield & P. Spencer 8083)	1995	*Scholtzia brevistylis* subsp. *prowaka* Rye
Scholtzia sp. Red Bluff (A. Gunness 2373)	1996	*Scholtzia longipedata* Rye subsp. *longipedata*
Scholtzia sp. Ross Graham Lookout (S Maley 6)	1994	*Scholtzia denticulata* Rye
Scholtzia sp. Shark Bay (M.E. Trudgen 7429)	1996	*Scholtzia capitata* F.Muell. ex Benth.

Phrase name or manuscript name	Year	Published name or comment
Scholtzia sp. Valentine Road (S. Patrick 2142)	1995	*Scholtzia thinicola* Rye
Scholtzia sp. Walebing (S. McNee 4)	2006	known from a single collection (see *S. halophila*)
Scholtzia sp. Whelarra (M.E. Trudgen 12018)	1994	known from a single collection (see *S. tenuissima*)
Scholtzia sp. Winchester (C. Chapman s.n. PERTH 05625386)	2010	*Scholtzia chapmanii* Trudgen ex Rye
Scholtzia sp. Wonganderrah (M.E. & M.R. Trudgen MET 12000)	2003	belongs to *Scholtzia involucrata* (Endl.) Druce complex
Scholtzia sp. Yandanooka (R. Soullier 646)	1999	*Scholtzia brevistylis* Rye
Scholtzia sp. Yenyening Lakes (A. Gunness 2824)	2003	*Scholtzia halophila* subsp. *meridionalis* Rye
Scholtzia sp. Yerina Springs (N. Hoyle 517)	2002	*Scholtzia capitata* F.Muell. ex Benth.
Scholtzia sp. Yuna (C.A. Gardner 14286)	2010	*Scholtzia cordata* Trudgen ex Rye
Scholtzia sp. Z-Bend (Bellairs-Kalflora 912a)	1994	*Scholtzia tenuissima* Rye

Fruit measurements were only taken from fertile fruits as far as possible. Fully mature fruits that are sterile contain hard structures formed from unfertilised ovules or inviable seeds; they tend to be somewhat larger than fertile fruits with a fully formed viable seed enclosed. A similar phenomenon was observed in *Thryptomene* Endl. (see Rye 2014: 274).

Taxonomy

Scholtzia Schauer, *Linnaea* 17: 241 (1843). *Baeckea* sect. *Scholtzia* (Schauer) Baill., *Hist. Pl.* 6: 358 (1876). *Type*: *Baeckea involucrata* Endl., *lecto*, *fide* B.L. Rye, *Nuytsia* 27: 160 (2017) [= *Scholtzia involucrata* (Endl.) Druce].

[*Pritzelia* Schauer ms, *Flora* 27: 407 (1843), *nom. inval. & nom. nud.*]

Piptandra Turcz., *Bull. Soc. Imp. Naturalistes Moscou* 35: 323 (1862). *Type*: *Piptandra spatulata* Turcz. [= *Scholtzia spatulata* (Turcz.) Benth.].

Shrubs prostrate to tall, up to 3(–4) m high, mostly without a lignotuber, glabrous. *Young stems* developing a loose, whitish epidermis, which is smooth or fairly smooth in nearly all species. *Leaves* opposite. *Petioles* usually well defined, but sometimes very reduced or absent. *Leaf blades* dorsiventrally compressed, obtuse. *Peduncles* up to 25 mm long, often many-flowered and with secondary axes, rarely consistently 1-flowered. *Sepals* often of varied shape within a flower, usually much shorter than, but up to about as long as, the petals, persistent in fruit, often with a longitudinal ridge on the base. *Petals* broadly ovate to circular, 1.0–4.5 mm long, white or pink, abruptly narrowed to a short claw at base, deciduous or (in some species) persistent (closed erect) in fruit. *Stamens* 3–30, antisepalous (often in irregular antisepalous groups) in most species, in a continuous circle in some species. *Anthers* (including basal connective gland) bent more or less at right angles to the filament to face the centre of the flower, somewhat 2-lobed, dehiscent by 2 terminal pores or short, ± vertical slits. *Ovary* 1–3-locular (rarely 4-locular in one taxon); ovules 1 or 2 per loculus, if 2 then superposed. *Style* 0.3–3.5 mm long; base inset in a cylindrical depression. *Fruits* indehiscent, inferior to *c.* 1/2 inferior, usually 1-seeded. *Seeds* unfacetted, usually ± obovoid, 0.8–1.9 mm long; testa thin, membranous.

Size and distribution. A Western Australian genus of more than 40 species, extending from near

Carnarvon south to near Harvey and inland to Anderson Rocks, north of Hyden, with a concentration of species in the northern sandplains of the South West Botanical Province. Kalbarri National Park is particularly rich, including more than a quarter of the species.

Etymology. The genus is dedicated to Johann Eduard Heinrich Scholtz (1812–1859), a physician and naturalist from Bratislava, who studied the flora and fauna of one of the provinces of Poland. Gender: feminine.

Chromosome numbers. Several species have been recorded with n = 11 and a single species, *S. drummondii* Benth., with the tetraploid number of n = 22 (Rye 1979).

Horticultural potential and fire tolerance. Several species are in cultivation as garden ornamentals. They have the advantage of being relatively drought-tolerant plants for Perth gardens, since most come from drier habitats. The local species *S. involucrata* is one of the best known species as it is widespread in the Perth metropolitan area. It is a small, single-stemmed shrub, often low-growing, and is readily killed by fires. Seedlings are commonly produced in the two years after fires, but rarely, if ever, during fire-free periods. Some single-stemmed species of *Scholtzia* are large, sturdy shrubs that may be able to survive low-intensity fires.

Species groups. Although *Scholtzia* is one of the largest genera in the tribe Chamelaucieae, no formal or informal infra-generic classification has been proposed for it. Stamen number and arrangement are of importance in distinguishing individual species or groups of species in the genus. When stamens are 15 or more, they are arranged in a complete circle (Figure 1A), and when of moderate number or fewer they are usually in obvious antisepalous groups (Figure 1B, C), although sometimes the stamens of an antisepalous group are quite widely separated. When there are very few stamens per flower, some of the antisepalous groups may be absent (see Figure 1D).

Scholtzia species can be divided into two groups based on whether they have two superposed ovules, or a solitary ovule, in each loculus of the ovary. Both situations are unknown in related genera, which have 3–25 radially arranged ovules per loculus or rarely two collateral ovules.

Most of the *Scholtzia* species with only one ovule per loculus have three ovary loculi, whereas species with two ovules per loculus are much more likely to have two loculi. However the number of loculi ranges from one to three in both categories, with just one member of each having a one-locular ovary. Past reliance on keys such as Blackall and Grieve (1980) has led to one-locular specimens often having been misidentified as members of consistently one-locular genera, such as *Thryptomene* and *Malleostemon* J.W.Green.

A much less complete difference between the two main groups is in stamen arrangement, but this is only evident when stamen numbers are low, as most members of the 2-ovulate group appear to always have at least one stamen opposite each sepal, so that the minimum number of stamens per flower is five, whereas members of the 1-ovulate group have up to two sepals without a stamen and a minimum number of three stamens per flower. However, *S. brevistylis* of the former group has antisepalous groups of 0–2 stamens, with a minimum of four stamens per flower. In this species, as in the 1-ovulate group, the most common arrangement of the stamens when there are five per flower is 2,0,1,2,0 around the circumference such that two sepals lack stamens but two others have two stamens and one has a single stamen.

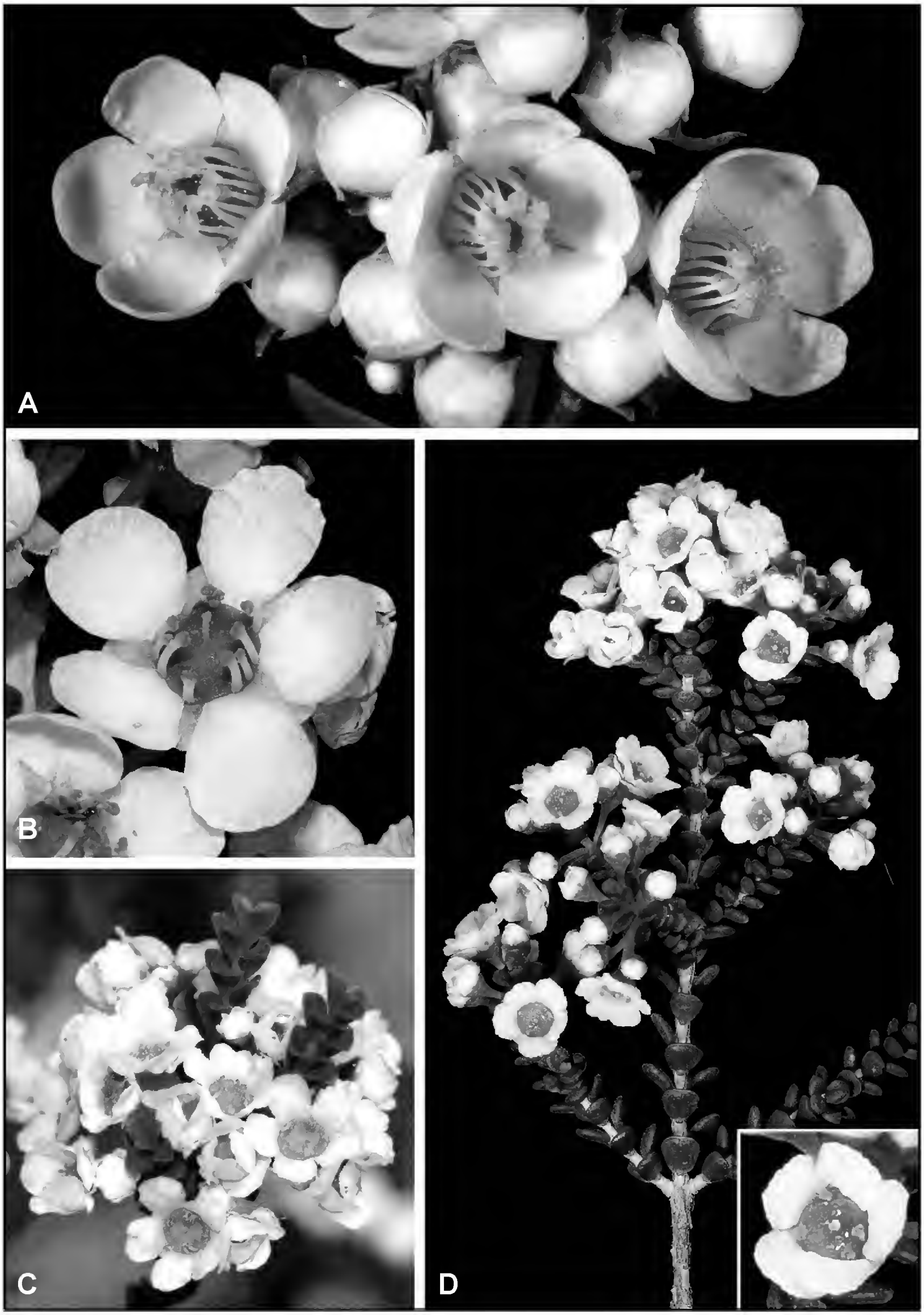

Figure 1. Images of *Scholtzia* species showing varied stamen arrangements. A – numerous stamens in a continuous circle in *S. involucrata*; B – ten antisepalous stamens in the arrangement 3,1,3,1,2 in a flower of *S. drummondii*; C – nine or ten stamens per flower, arranged mostly in close pairs opposite each sepal, in *S. halophila*; D – three or four, widely spaced stamens per flower in *S. uniovulata*, showing one enlarged flower with four antisepalous stamens in the arrangement 2,0,1,1,0. Taken by Kevin Thiele at Inglewood, voucher *K.R. Thiele* 3159 (A) and near Kellerberrin, voucher *K.R. Thiele* 3859 (D); by Rob Davis from near Irwin River, voucher *R. Davis* 11272 (B); and by Jean Hort from near Cunderdin (C).

Key to species and subspecies of *Scholtzia*

*taxa that appear in more than one section of the key

1. Stamens (10–)13–30, in a continuous circle, with antipetalous stamens as well as antisepalous ones

2. Ovary 3-locular; ovules 1 per loculus. Erect shrubs up to 2.5 m high, occurring north of Geraldton

3. Peduncles absent or up to 0.5 mm long, 1-flowered. Sepals 0.7–1.3 mm long (Binnu area) .... **S. uniflora**

3: Peduncles 7–13 mm long, 5–15-flowered. Sepals 0.4–0.8 mm long (Nolba area) .... **S.** sp. **Nolba**

2. Ovary 2-locular; ovules 2 per loculus, superposed. Mostly prostrate or low-growing shrubs but one variant of *S. involucrata* up to 3 m high, occurring south of Geraldton

4. Leaves markedly laciniate-ciliate; longest cilia 0.4–0.8 mm long (near Lancelin–N of Seabird–Moore River NP) .... **S. laciniata**

4: Leaves entire to moderately laciniate-ciliate; longest cilia (when present) up to 0.4 mm long

5. Peduncles 3–7-flowered. Outer (and inner) sepals scarious throughout, not ridged (Eneabba–near Harvey) .... **S. involucrata** complex

5: Peduncles 1–3-flowered, all or mostly 1-flowered in most taxa. Outer sepals longitudinally ridged at the base

6. Leaves about as thick as wide, with margins poorly defined (rounded) and entire except for a few apical teeth. Flowers borne usually at 2–7 consecutive nodes (Meckering–Youndegin area) .... **S. eatoniana**

6: Leaves usually wider than thick, angled on each edge to form distinct margins, often denticulate along most or distal parts of the margins. Flowers borne at up to 35 consecutive nodes, rarely all at fewer than 10 nodes

7. Leaves ovate to linear, 3.5–10 mm long. Peduncles 1–3-flowered

8. Leaves flat, with the longest lacinia or cilia 0.2–0.4 mm long. Petals 3.5–4.5 mm long. Antipetalous stamens with a filament *c.* 3.3 mm long (Bickley area) .... **S.** sp. **Bickley**

8: Leaves usually somewhat thickened on a fold, entire or denticulate-ciliolate. Petals 2.5–3 mm long. Antipetalous stamens with a filament 1.8–2.4 mm long (near Eneabba–near Moore River) .... **S. teretifolia**

7: Leaves obovate to broadly elliptic or narrowly obovate to linear, 1.2–5 mm long. Peduncles all or nearly all 1-flowered

9. Leaves ± entire. Peduncles 3–7 mm long. Mature style (including embedded part) commonly 2.5–3.4 mm long (Gunyidi–Dalwallinu) .... **S. quindecim**

9: Leaves toothed along the margins, sometimes becoming entire with age. Peduncles 1.5–3 mm long. Mature style (including embedded part) 1.5–2.3 mm long

10. Leaves narrowly obovate to linear, 1.2–3 mm long. Hypanthium distinctly 5-ribbed, each rib connecting to a marked ridge on the base of a sepal. Stamens 15–20 (W of Eneabba–near Winchester) .... **S. chapmanii**

10: Leaves obovate to broadly elliptic, 2.5–4.5 mm long. Hypanthium not appearing 5-ribbed, the sepals only moderately ridged at the base. Stamens 11–17 (E of Walkaway)..**S. prostrata**

1: Stamens 3–12(–14), grouped opposite the sepals, with no antipetalous stamens

11. Ovules 1 per loculus

12. Leaves rather densely covered by fairly uniform oil glands on abaxial surface; foliar colleters up to 0.6 mm long on each side of the petiole of young leaves. Sepals fairly erect in flower and fruit

13. Leaves broadly to depressed obovate, 0.5–2.5 mm long, usually with midvein not noticeably raised or only at the apex. Hypanthium about as broad as long, commonly 1.5–1.6 mm long in fruit. Peduncles 3–14-flowered (Coburn Stn–near Binnu).. **S. oleosa**

13: Leaves narrowly to broadly obovate, 2.5–5 mm long, usually with midvein ridged for about half or more of the lamina. Hypanthium longer than broad, commonly 2–2.5 mm long in fruit. Peduncles 9–23-flowered (Tamala Stn–Yerina Springs) ....**S. capitata**

12: Leaves with few or more scattered oil glands on abaxial surface, usually with central glands much larger than lateral ones; foliar colleters minute or apparently absent. Sepals somewhat to markedly incurved in flower and fruit in most species but spreading in fruit in *S. uniovulata*

14. Hypanthium wrinkled-rugose or reticulate, with lowered areas not very deep or not restricted to oil glands

15. Flowers borne at 5–42 consecutive nodes on most branchlets and with many or all of them occurring well below apex of flowering branchlets (i.e. not all in terminal clusters). Most flowers with 4–6 stamens and a 2-locular ovary, and all with sepals of fairly uniform length

16. Leaf blades 2.3–3 mm wide. Peduncles 5–7 mm long, 3–15-flowered (near Kojarena–E of Walkaway).. **S. multiflora**

16: Leaf blades 1.8–2.3 mm wide. Peduncles 2–2.5 mm long, 1–3-flowered (near Winchester)... **S.** aff. **multiflora**

15: Flowers borne at 1–5(–8) consecutive nodes on most branchlets, either all in ± terminal clusters or at very few nodes. Flowers not matching above choice in all characters, most commonly by having 6–11 stamens or a 3-locular ovary

17. Leaf blades 2–7 × 2–4 mm, scarcely thickened (Eurardy Stn area–Canning River) ....**S. laxiflora** complex

17: Leaf blades 1.0–2.5 × 0.8–2.1 mm, usually distinctly thickened towards the centre

18. Peduncles 3–5 mm long, 3–7-flowered. Flowers most commonly with a 3-locular ovary and 5 stamens

19. Leaf blades obovate, 0.8–1.4 mm wide. Hypanthium 0.7–0.9 mm long. Petals 1.0–1.2 mm long (Dongara–Drovers Cave NP)...**S. calcicola**

19: Leaf blades broadly obovate, 1.3–2.1 mm wide. Hypanthium 1.2–1.4 mm long. Petals 1.3–1.6 mm long (Coburn–southern Zuytdorp Cliffs)........................ **S. corrugata**

18: Peduncles 0.4–2.3 mm long, 1–3-flowered. Flowers either with a 2-locular ovary or mostly with more than 5 stamens

20. Inner sepals much larger than outer ones. Stamens 3–6 (East Yuna NR–Wicherina area) .... **S. inaequalis**

20: Inner sepals not markedly different from outer ones. Stamens mostly 6–11 (N of Eurardy Stn–Indarra) .... **S. truncata***

14: Hypanthium rugose-pitted, the shallow to very deep pits containing a sunken oil gland

21. Peduncles 3.5–14 mm long, 3–12-flowered

22. Petioles absent or up to 0.25 mm long. Occurring in non-saline habitats (Morawa area) .... **S. subsessilis***

22: Petioles 0.3–0.7 mm long. Occurring in subsaline habitats

23. Stamens 5–8. Ovary 2-locular in all or most flowers (Yenyening Lakes NR) .... **S. halophila** subsp. **meridionalis**

23: Stamens 7–12. Ovary 2- or 3(4)-locular, most specimens with about half or more of the ovaries 3-locular

24. Inner sepals 1.0–1.4 mm long (Mortlock River branches).. **S. halophila** subsp. **mortlockensis**

24: Inner sepals 0.5–0.8 mm long (near Coorow–Tammin area) .... **S. halophila** subsp. **halophila**

21. Peduncles 0.4–2.5(–3.5) mm long, 1–6-flowered

25. Ovary 3-locular. Peduncles at least 2.5 mm long and 3–6-flowered (Morawa area) .... **S. subsessilis***

25: Ovary 1- or 2-locular (possibly rarely 3-locular in *S. truncata*). Peduncles 0.5–2.5 mm long and/or 1–3-flowered

26. Stamens (5–)7–12, always more than 6 in some flowers. Mature style (including embedded part) 0.9–1.6 mm long (N of Eurardy Stn–Indarra) .... **S. truncata***

26: Stamens 3–6, always 5 or fewer in most flowers. Mature style (including embedded part) 0.45–0.8 mm long

27. Sepals mostly spreading in fruit; innermost one 0.8–1.2 mm long. Hypanthium pitted but usually not as deeply as in *S. parviflora*. Ovary 1-locular or much less commonly 2-locular (Northampton–Corrigin–Anderson Rocks) .... **S. uniovulata**

27: Sepals more erect or incurved in fruit; innermost one 0.3–0.6 mm long. Hypanthium deeply rugose-pitted. Ovary 2-locular (Hill River area–Moore River–Watheroo NP) .... **S. parviflora**

11: Ovules 2 per loculus, superposed

28. Ovary 3-locular in all or most flowers or (in *S. oligandra*) sometimes 2-locular in up to half of the flowers

29. Stamens 5–8, commonly 5 with 1 opposite each sepal. Ovary 2-locular in up to half of the flowers. Mature style (including embedded part) 0.6–1 mm long (Kalbarri–near Lucky Bay) .... **S. oligandra**

29: Stamens usually 8–14, rarely 6 or 7 (but then with mature style 1–1.6 mm long), with 0–4 opposite each sepal. Ovary 3-locular in all or nearly all of the flowers. Mature style (including embedded part) 0.7–1.6 mm long

30. Peduncles 0.4–6(–10) mm long, 1–3-flowered

31. Leaves ciliate to laciniate; longest cilia 0.2–0.4 mm long. Peduncles 0.4–2.1 mm long. Stamens 6–10 (Howatharra Hills area–N of Irwin River).. **S. ciliata**

31: Leaves entire, denticulate or ciliolate; longest cilia less than 0.2 mm long. Peduncles 2–6(–10) mm long. Stamens 10–14 (Maya–Tammin area).. **S. drummondii**

30: Peduncles 4–25 mm long, mostly 3–15-flowered

32. Bracts 2–5 mm long. Petals 2.5–3.5 mm long. Largest stamens usually with a filament 1–1.3 mm long (Kalbarri NP–Binnu area –Howatharra).. **S. spatulata**

32: Bracts 0.9–1.8 mm long. Petals 1.5–2.5 mm long. Largest stamens with a filament 0.4–0.7 mm long (E of Geraldton–Watheroo NP).. **S. trilocularis**

28: Ovary 1- or 2-locular in all or most flowers

33. Leaves broadly to depressed orbicular-cordate or broadly ovate to depressed obovate, consistently broader than long

34. Leaves sessile, somewhat stem-clasping at base, 1.3–1.8 mm long, 1.5–2.5 mm wide, 0.5–1.1 mm thick (Eurardy Stn).. **S. peltigera**

34: Leaves distinctly petiolate at base, 2.2–7 mm long, 2.5–9 mm wide, not very thick

35. Flowers borne at 1–4 consecutive nodes. Mature style 0.8–1.4 mm long (Kalbarri NP–N of Yuna).. **S. cordata**

35: Flowers mostly borne at 8–23 consecutive nodes. Mature style 0.3–1.0 mm long

36. Stamens always or mostly 6–10 per flower, 1–3 opposite each sepal. Bracts 0.6–1.6 mm long. Mature style 0.45–1.0 mm long

37. Leaf blades broadly or very broadly obovate, with lateral veins usually obscure. Peduncles 2–4 mm long. Petals persistent in fruit (Kalbarri NP area).. **S. bellairsiorum**

37: Leaf blades broadly to depressed orbicular-cordate, with lateral veins clearly visible. Peduncles 5–15 mm long. Petals deciduous in fruit (Murchison River–near Balline Homestead).. **S. uberiflora**

36: Stamens always or mostly 5 per flower, 1 opposite each sepal. Bracts 1.3–3 mm long. Mature style 0.3–0.4 mm long

38. Bracts 1.3–1.8 mm long. Ovary 1-locular (Ajana–Greenough).. **S. pentamera** subsp. **pentamera**

38: Bracts 2–3 mm long. Ovary 2-locular (Moresby Range)............... **S. pentamera** subsp. **collina**

33: Leaves of varied shape, all or mostly longer than broad

39. Petioles 0.1–0.35 mm long

40. Leaves with a recurved apex produced into a minute point (Meadow Stn area) .... **S. recurva**

40: Leaves with a straight apex and no point (except sometimes on the youngest leaves of *S. thinicola*)

41: Peduncles 0.7–4 mm long, 0.4–0.7 mm wide. Sepals with a herbaceous base that is longitudinally ridged (near Yandi Stn –W of Mullewa) .... **S. thinicola**

41. Peduncles 5.5–13 mm long 0.15–0.35 mm wide. Sepals scarious throughout, not ridged

42. Leaves ± obovate, 0.6–1.0 mm wide. Secondary axes up to 2.5 mm long (Kalbarri NP) .... **S. tenuissima**

42: Leaves obovate to broadly elliptic, 1.0–1.5 mm wide. Secondary axes up to 0.7 mm long (E of Binnu) .... **S.** sp. **Whelarra**

39: Petioles 0.4–1.1 mm long

43. Stamens 4–6, usually 5, with no stamens opposite one or two sepals of each flower

44. Leaves 1.3–1.6 mm wide, with fairly flat margins. Inflorescences extending for 3–8 nodes, tending to be concentrated into a small zone towards the ends of the branchlets; peduncles of the lowest node 2–4 mm long (Carnamah–Coorow area) .... **S. brevistylis** subsp. **prowaka**

44: Leaves either wider than 1.6 mm or with recurved margins (at least towards the base). Inflorescences extending for 5–14 nodes but usually spike-like, usually well below the apex of each branchlet; peduncles of the lowest node 1–2(–3) mm long

45. Leaves with margins recurved, at least at base, the largest ones 1.0–1.5 mm wide. (Mingenew area–Yandanooka area) .... **S. brevistylis** subsp. **brevistylis**

45: Leaves with margins fairly flat, the largest ones 2.0–2.4 mm wide. (Nebroo Hill area) .... **S. brevistylis** unnamed variant

43: Stamens 5–11, mostly more than 5, with at least one stamen opposite each sepal

46: Leaves entire. Flowers with a hypanthium 1.0–1.6 mm long and sepals up to 0.75 mm long

47. Outer sepals 0.3–0.5 mm long, smooth or shortly ridged. Stigma peltate or capitate (Kalbarri NP–E of Balline) .... **S. longipedata** subsp. **longipedata**

47: Outer sepals (0.4–)0.5–0.75 mm long, with base ridged for most of length. Stigma capitate (East Yuna NR – Eradu) .... **S. longipedata** subsp. **procera**

46. Leaves initially denticulate-ciliolate, sometimes becoming entire as they age. Flowers either with a long hypanthium (more than 1.6 mm long) or long sepals (more than 1 mm long)

48. Hypanthium 1.0–1.6 mm long, rugose, not ribbed. Inner sepals 1.3–2.5 mm long (Kalbarri NP) .... **S. denticulata**

48: Hypanthium 1.8–2.5 mm long, 5-ribbed at least in distal part. Inner sepals 0.3–0.6 mm long (N of Carnarvon–Lancelin) .... **S. obovata** complex

Scholtzia bellairsiorum Rye, *sp. nov.*

Typus: Kalbarri National Park, Western Australia [precise locality withheld for conservation reasons], 24 October 1995, *M.N. Lyons* 2411 (*holo*: PERTH 05002257; *iso*: K, MEL).

Scholtzia sp. Ajana (T.A. Halliday 137), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 401 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 0.9–3 m high, width not recorded; flowering branchlets with peduncles borne at up to 20 consecutive nodes in a raceme-like arrangement, but usually at 5–10 nodes and more clustered, in both cases usually well below apex of branchlet. *Leaves* antrorse to patent. *Petioles* 0.5–1.1 mm long. *Leaf blades* broadly or very broadly obovate, 3.5–5.5 mm long, 3–5 mm wide, with a translucent margin up to *c.* 0.1 mm deep, entire; abaxial surface flat except for a slight narrow furrow or ridge along midvein, with lateral veins usually obscure, the oil glands in more than 3 rows on each side of midvein but inconspicuous. *Peduncles* 2–4 mm long, 0.4–0.6 mm wide, mostly 7–12-flowered; secondary axes up to 1 mm long. *Bracts* 0.6–1.6 mm long, caducous. *Pedicels* 0–1.2 mm long. *Flowers* 4–5.3 mm diam. *Hypanthium* 1.5–1.8 mm long, rugose. *Sepals* mostly broadly to depressed ovate, 0.5–1.0 mm long, the outer ones with base somewhat ridged; petaline margin 0.4–0.6 mm deep, entire. *Petals* 1.5–2.0 mm long, white or pale pink. *Stamens* 7–10, with 1–3 opposite each sepal. *Longest filaments* 0.2–0.4 mm long. *Anthers* 0.35–0.4 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.5–1.0 mm long; stigma capitate. *Fruits* largely inferior, 2.0–2.5 mm long, 1.6–1.8 mm wide; sepals erect; petals persistent. *Seeds* 1.3–1.8 mm long, 0.6–0.8 mm wide.

Diagnostic features. Among species that have a 2-locular ovary with 2 ovules per loculus, *S. bellairsiorum* is distinguished by the following combination of characters: leaves broadly or very broadly obovate, with lateral veins usually obscure; peduncles 2–4 mm long; stamens 7–10; petals persistent in fruit.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Oct. 1974, *J.S. Beard* 7137 (PERTH); 10 Oct. 1995, *D.R. Bellairs s.n.* (PERTH); 12 Jan. 2005, *A. Crawford* 867 (PERTH); 19 Dec. 1968, *H. Demarz* 925 (PERTH)

Distribution and habitat. Occurs in the eastern part of Kalbarri National Park (Figure 2A), on sandplain, often dominated by *Banksia*.

Phenology. Flowers from September to December. Mature fruits recorded from November to January.

Etymology. Named in honour of Don and Barbara Bellairs, who collected extensively in the Kalbarri area over their many years of residence there, and kept a local herbarium. They were the first to collect a number of rare species from Kalbarri National Park and nearby, including *S. tenuissima* Rye, and are the only collectors of *Thryptomene pinifolia* Rye & Trudgen.

Conservation status. Priority Three under Conservation Codes for Western Australian Flora. Listed with this conservation status by Smith and Jones (2018) under the name *S.* sp. Ajana (T.A. Halliday 137).

Affinities. *Scholtzia bellairsiorum* is closest in morphology to *S. uberiflora* F.Muell. and *S. pentamera* Rye, but those species have more obviously veined leaves, longer peduncles (4–15 mm long) and less persistent petals, and *S. pentamera* also differs in having only five stamens.

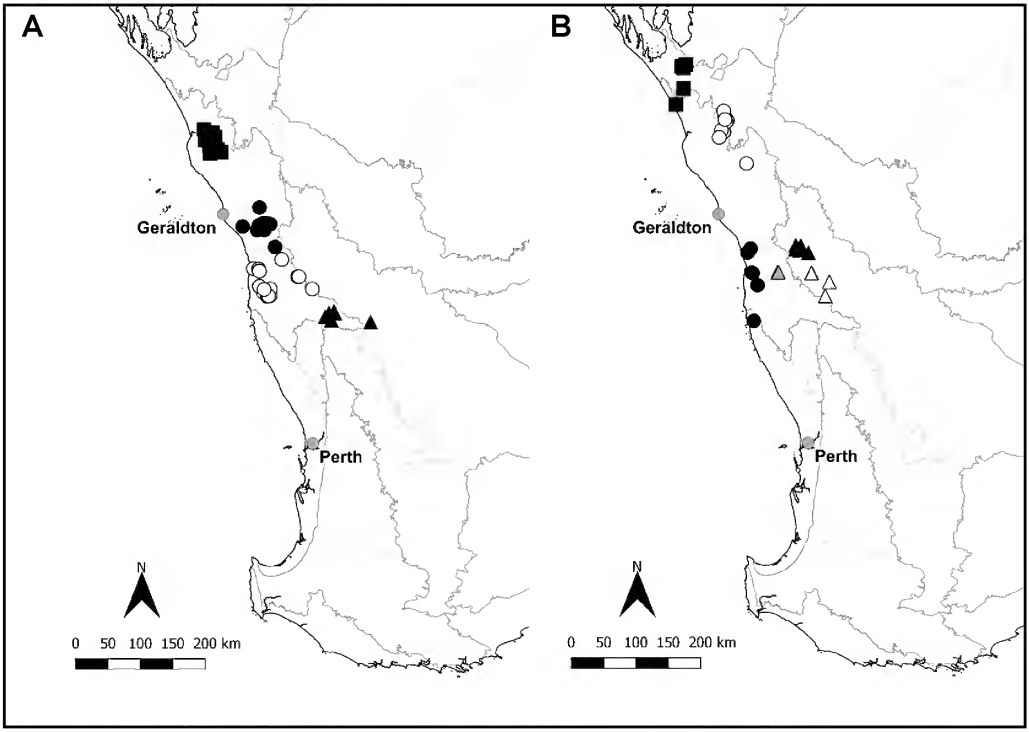

Figure 2. Distribution of *Scholtzia* species and subspecies. A – *S. bellairsiorum* (■), *S. chapmanii* (○), *S. prostrata* (●) and *S. quindecim* (▲); B – *S. brevistylis* subsp. *brevistylis* (▲), *S. brevistylis* subsp. *prowaka* (△), unnamed variant of *S. brevistylis* (▲), *S. calcicola* (●), *S. cordata* (○) and *S. corrugata* (■).

Scholtzia brevistylis Rye, *sp. nov.*

Typus: Yandanooka, Western Australia [precise locality withheld for conservation reasons], November 1998, *R. Soullier* 646 (*holo*: PERTH 05447860; *iso*: K, MEL).

Shrub 0.6–2.5 m high, commonly 0.9–2 m wide, rather spindly; flowering branchlets commonly with peduncles borne at 4–15 consecutive nodes in a raceme-like arrangement. *Leaves* antrorse to patent. *Petioles* 0.4–0.8 mm long. *Leaf blades* obovate, 2–4.5 mm long, 1.0–2.4 mm wide, with a clear-translucent margin up to *c.* 0.1 mm deep, entire; abaxial surface gradually raised towards centre, sometimes grooved along midvein, with lateral veins obscure, the oil glands usually in 2 main rows on each side of midvein, with 4–7 glands in innermost rows. *Peduncles* 1–4 mm long, 0.25–0.3 mm wide, 3–7-flowered; secondary axes up to 0.5 mm long. *Bracts* 0.7–2.0 mm long, deciduous or caducous. *Pedicels* 0.2–0.6 mm long. *Flowers* 3–3.5 mm diam. *Hypanthium* 0.6–1.0 mm long, smooth to somewhat glandular-rugose. *Sepals* almost deltate to depressed ovate, 0.3–0.5 mm long, the outer ones often with a green ridge; petaline margin 0.25–0.4 mm deep, entire. *Petals* 1.2–1.5 mm long, white or pale pink. *Stamens* 4–6, usually 5, with 0–2 opposite each sepal. *Longest filaments* 0.2–0.4 mm long. *Anthers* 0.2–0.25 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.3–0.6 mm long; stigma capitate. *Fruits* 2/3–3/4 inferior, 1.3–1.5 mm long, 1.0–1.2 mm wide; sepals erect or incurved; petals deciduous. *Seeds* 1.0–1.3 mm long, 0.5–0.6 mm wide.

Diagnostic features. Distinguished from all other named species of *Scholtzia* by the combination of a short style (0.3–0.6 mm long) and 4–6 stamens with 0–2 opposite each sepal. Other important characters:

3–7-flowered peduncles, the smooth to somewhat glandular-rugose (i.e. not pitted) hypanthium and 2 ovules per loculus.

Distribution and habitat. Occurs from the Mingenew area south to the Nebroo Hill area and south-east to the Coorow area (Figure 2B).

Etymology. From the Latin *brevis* (short) and *-stylis* (styled), as this species has a shorter style than any other member of the genus except for *S. pentamera*.

Affinities. *Scholtzia brevistylis* is very distinctive, its affinities uncertain. It is readily distinguished from the other particularly short-styled species, *S. pentamera*, for example in its narrower leaves, which are longer than broad, shorter peduncles and smaller flowers. Although *S. brevistylis* has two ovules per loculus, it is similar to a number of species with a single ovule per loculus in having one or two sepals with no stamen opposite them. Most flowers have five stamens in the sequence 2,0,1,2,0 around the circumference of the flower, i.e. with a maximum of two stamens opposite each sepal.

Notes. Three groups of specimens are included here, from the northern, southern and western parts of the range respectively. The poorly known western variant is described informally below, while the other two variants are treated as subspecies *brevistyla* and *prowaka*.

a. Scholtzia brevistylis Rye subsp. **brevistylis**

Scholtzia sp. Yandanooka (R. Soullier 646), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Leaf blades 1–1.5 mm wide, with margins usually markedly recurved, at least at base. *Flowering branchlets* with peduncles borne at 5–11 consecutive nodes in a raceme-like arrangement 10–60 mm long, always with some over 20 mm long, usually well below the end of the branchlet; peduncles of the lowest node 1–2(–3) mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 Nov. 1996, *A. Carr* 383 (PERTH); 10 Dec. 2015, *A. Crawford* ADC 2646 (PERTH); 2 Dec. 1999, *S.J. Patrick* 3358A (NSW, PERTH); Oct. 1997, *R. Soullie*r 431 (PERTH).

Distribution and habitat. Occurs in the Mingenew to Yandanooka area (Figure 2B), often on sandplain, sometimes on the margins of granite outcrops or associated with damp depressions.

Phenology. Flowers from October to early December. Mature fruits recorded in November and December.

Conservation status. Priority One under Conservation Codes for Western Australian Flora. Listed with this conservation status by Smith and Jones (2018) under the name *S.* sp. Yandanooka (R. Soullier 646).

b. Scholtzia brevistylis subsp. **prowaka** Rye

Typus: east of Carnamah, Western Australia [precise locality withheld for conservation reasons], 7 September 2006, *M. Hislop, P. Aynsley & J. Borger* MH 3650 (*holo*: PERTH 07403267; *iso*: K, MEL).

Scholtzia sp. Prowaka Springs (R.J. Cranfield & P. Spencer 8083), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https:// florabase. dpaw.wa.gov.au/ [accessed 2 March 2018].

Leaf blades 1.3–1.6 mm wide, with margins fairly flat. *Flowering branchlets* with peduncles borne at 3–8 consecutive nodes in a short raceme-like arrangement up to 15 mm long, tending to be concentrated into a small zone towards the end of the branchlet; peduncles of the lowest node 2–4 mm long.

Diagnostic characters. Differs from subsp. *brevistylis* in usually having longer peduncles and leaves with fairly flat margins.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 Oct. 2006, *J. Borger* AK 1610-12 (CANB, NSW, PERTH); 24 June 2008, *J. Borger* IB 246-08 (CANB, NSW, PERTH); 19 Sep. 1991, *R.J. Cranfield* 8083 *& P.J. Spencer* (PERTH).

Phenology. Flowers from late June to September, with mature fruits recorded in October.

Distribution and habitat. Extends from north of Carnamah to south-east of Coorow (Figure 2B), on granite outcrops, also recorded on laterite.

Etymology. Named after Prowaka Springs, as this subspecies was first collected near there.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Previously listed (Smith & Jones 2018) as Priority One under the name *S.* sp. Prowaka Springs (R.J. Cranfield 8083 & P.J. Spencer). Only four collections have been made of this taxon, but it is known from a nature reserve.

Notes. Flowering branchlets often have peduncles borne at, or fairly close to, the apex of the branchlet, whereas in subsp. *brevistylis* and the unnamed eastern variant, the uppermost peduncles are usually well below the apex of each branchlet.

c. Scholtzia brevistylis unnamed eastern variant

Leaf blades 2.0–2.4 mm wide, with margins fairly flat. *Flowering branchlets* with peduncles borne at 5–14 consecutive nodes in a raceme-like arrangement 15–70 mm long, always with some over 20 mm long, usually well below the end of the branchlet; peduncles of the lowest node 1–2 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 17 Oct. 2007, *J. Borger* BR 1710–14 (PERTH); 17 Nov. 2009, *J. Borger* NR21 5 (PERTH); 10 Oct. 2002, *S. Patrick* 4498 (CANB, PERTH).

Phenology. Flowers from October to December.

Distribution and habitat. Restricted to a small area near Nebroo Nature Reserve (Figure 2B), apparently associated with damp habitats or on hillsides, recorded in sandstone, siltstone or ironstone gravel.

Notes. The three specimens placed here have broader leaves than either of the named subspecies. They

match subsp. *brevistylis* in their inflorescences but have fairly flat leaf margins as in subsp. *prowaka*. More collections are needed to assess the taxonomic status of this variant.

Scholtzia calcicola Rye, *sp. nov.*

Typus: south-west of Dongara, Western Australia [precise locality withheld for conservation reasons], 9 December 2002, *R.P. Hart* 8401 (*holo*: PERTH 06256449; *iso*: CANB, K, MEL, NSW).

Scholtzia sp. Dongara (R. Hart 8401), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub erect, dense, 0.2–2 m high, 0.3–1.2 m wide; flowering branchlets mostly with peduncles borne at 2–8 consecutive nodes, in a raceme-like arrangement or sometimes with flowers in a globular cluster. *Leaves* appressed or antrorse. *Petioles* 0.2–0.4 mm long. *Leaf blades* obovate, 1.8–2.5 mm long, (0.8–)1.2–1.4 mm wide, entire, obtuse, not apiculate; abaxial surface flattened at the centre in basal 1/2–3/4 of its length and often with midrib ridged distally, with lateral veins obscure, the oil glands in 1 or 2 main rows on each side of midvein, with 3–6 glands in innermost rows. *Peduncles* 3–5 mm long, 0.2–0.35 mm wide, mostly 3–7-flowered; secondary axes up to 0.6 mm long. *Bracts* 0.6–0.8 mm long, deciduous. *Pedicels* absent or up to 0.3 mm long. *Flowers* 2.5–3.5 mm diam. *Hypanthium* 0.7–0.9 mm long, wrinkled or reticulate-rugose. *Sepals* broadly to depressed ovate, 0.35–0.5 mm long, the base ridged; petaline margin 0.15–0.3 mm deep, entire. *Petals* 1.0–1.2 mm long, usually pale pink. *Stamens* commonly 5, with 0–2 opposite each sepal. *Longest filaments* 0.25–0.35 mm long. *Anthers* 0.25–0.3 mm long. *Ovary* inferior, 3-locular; ovules 1 per loculus. *Style c.* 0.6 mm long; stigma capitate. *Fruits* globular, 2/3–3/4 inferior, 1.3–1.35 mm long, 1.1–1.2 mm wide; sepals strongly incurved; petals deciduous. *Seeds* 1.0–1.1 mm long, *c.* 0.8 mm wide.

Diagnostic features. Among species that have 1 ovule per loculus, *S. calcicola* is distinguished by the following combination of characters: leaves 0.8–1.4 mm wide; hypanthium wrinkled or reticulate-rugose, 0.7–0.9 mm long; petals 1.0–1.2 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 11 Nov. 2014, *S. Ruoss* SBR 020 (PERTH); 16 Oct. 2014, *T. Stehbens & D. Panickar* TS 003 (PERTH); 16 Oct. 2014, *T. Stehbens & D. Panickar* TS 005 (PERTH); 26 Sep. 1984, *R.T. Wills s.n.* (PERTH); 14 Oct. 2011, *G. Zemunik* 25 (PERTH).

Distribution and habitat. Recorded from near Dongara south to Drovers Cave National Park (Figure 2B), in heath on shallow sand over limestone.

Phenology. Flowers from October to December.

Etymology. From the Latin *calcis* (lime) and *-cola* (inhabitant), as the species is found in limestone habitats.

Vernacular name. Tiny-flowered Scholtzia.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Previously listed (Smith & Jones 2018) as Priority One under the name *S.* sp. Dongara (R. Hart 8401), this species has recently been collected from a National Park and its known range extended to about 100 km.

Affinities. This belongs to a species group that has the sepals strongly incurved, both in flower and fruit. It shows greatest similarity to *S. corrugata* but that species occurs much further north and differs in having broader leaves and larger flowers with a longer hypanthium (see key). *Scholtzia multiflora* is closer in distribution to *S. calcicola* but has more numerous flowers and a 2-locular ovary.

Co-occurring species. Recorded growing with a member of the *S. obovata* complex (*G. Zemunik* 24).

Notes. *Scholtzia calcicola* has the smallest flowers in the genus. Its fruits are particularly delicate and dotted with somewhat glittering oil glands.

Scholtzia capitata F.Muell ex Benth., *Fl. Austral.* 3: 69 (1867). *Baeckea capitata* (F.Muell. ex Benth.) F.Muell., *Syst. Census Austral. Pl.* 54 (1883). *Type*: Murchison River, Western Australia, 1859–1863, *A.F. Oldfield s.n.* (*lecto*: MEL 2278625,*fide* B.L. Rye, *Nuytsia* 28: 161 (2017); *isolecto*: K 000357124, MEL 2278624).

Scholtzia sp. Shark Bay (M.E. Trudgen 7429), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Yerina Springs (N. Hoyle 517), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 0.4–3 m high, 0.5–4 m wide; flowering branchlets with peduncles mostly borne at 1–3 consecutive nodes, often in an umbel-like arrangement. *Leaves* widely antrorse or patent; foliar colleters (one on each side of the petiole of young leaves) filiform, 0.35–0.6 mm long, white. *Petioles* 0.5–1 mm long. *Leaf blades* narrowly to broadly obovate, 2.5–5 mm long, 1.3–3.5 mm wide, usually not very thick; abaxial surface usually ridged along midvein for at least half the blade length, sometimes deep bluish green, entire; abaxial surface with lateral veins obscure, the oil glands densely covering the surface rather than in rows. *Peduncles* 8–18 mm long, 0.5–0.8 mm wide, usually 9–23-flowered; secondary axes up to 1.3 mm long. *Basal bracts* 1.8–2.3 mm long. *Pedicels* 0.5–1.0 mm long. *Flowers* 4.3–4.8 mm diam. *Hypanthium* 1.1–1.4 mm long, densely glandular and pitted, each gland depressed below the surface and forming the full area of the pit. *Sepals* ovate to oblong or semicircular, commonly broadly ovate, (0.5–)0.8–1.3 mm long, thickened or ribbed and reddish at base; petaline margin 0.4–0.8 mm deep, entire. *Petals* 1.5–1.8 mm long, pale to medium pink. *Stamens* 6–10, with 0–3 opposite each sepal. *Longest filaments* 0.2–0.35 mm long. *Anthers c.* 0.35 mm long. *Ovary* inferior, 2-locular; ovules 1 per loculus. *Style* usually 0.6–1 mm long; stigma capitate or peltate. *Fruits* 1/2–2/3 inferior, 2–2.5 mm long, *c.* 1.6 mm wide; sepals erect; petals deciduous or persistent. *Seeds* 1.2–1.4 mm long, *c.* 0.6 mm wide.

Diagnostic features. Among species that have 1 ovule per loculus, *S. capitata* is distinguished by the following combination of characters: leaves densely glandular; peduncles 8–18 mm long, usually 9–23-flowered; hypanthium densely glandular and pitted, longer than wide; stigma capitate.

Selected specimens examined. WESTERN AUSTRALIA: between Hamelin and Tamala, 16 Oct. 1974, *J.S. Beard* 7067 (PERTH); near the Murchison river on the River Rd track, 2.5 km N of Kalbarri, 5 Oct. 1990, *S. Maley* 3 (AD, CANB, PERTH); 6.7 km from Tamala–Useless Loop fork on road to Hamelin Pool, 18 Sep. 1974, *B.L. Powell* 74090 (PERTH); Meanarra Hill, Kalbarri National Park, 29 Oct. 1996, *R. Schuh & G. Cassis* 96-33 (PERTH).

Distribution and habitat. Extends from Tamala Station south-south-east to near Yerina Springs (Figure 3A), in yellowish to reddish sandy soils. See below for a discussion of an outlying collection (*F. Hort & J. Hort* 3797) from the Perth suburb of Stratton.

Conservation status. Not listed by Smith and Jones (2018); this species has most of its known populations protected within Kalbarri National Park.

Chromosome number. $n = 11$, *fide* B.L. Rye, *Austral. J. Bot.* 27: 572 (1979) [as *Scholtzia* sp.]. Voucher: *B.L. Powell* 74090.

Phenology. Flowers mainly from August to October. Fruits recorded from October and January.

Etymology. From the Latin *capitatus* (capitate, head-like), referring to the head-like arrangement of the flowers, which are actually in a condensed dichasial cyme.

Vernacular name. Pom-pom Scholtzia.

Affinities. This species and *S. oleosa* Rye are referred to here as the *S. capitata* complex. They have crowded oil glands on the leaves and also on the hypanthium, with the glands sunken into small pits on the hypanthium. See *S. oleosa* for the differences between the two species.

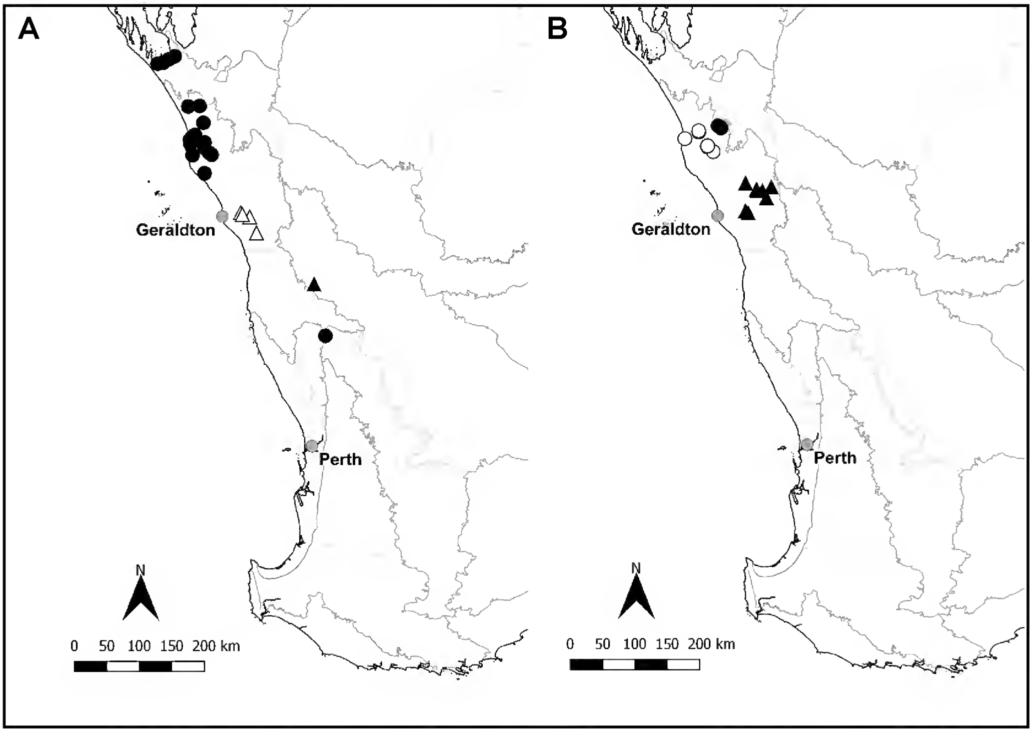

Figure 3. Distribution of *Scholtzia* species. A – *S. capitata*, with outlying southern collection (●), *S. multiflora* (△) and *S. aff. multiflora* (▲); B – *S. denticulata* (○), *S. inaequalis* (▲) and *S. peltigera* (●).

Notes. When this species was lectotypified in Rye (2017), it comprised only the specimens that had been housed under the phrase name *S.* sp. Yerina Springs (N. Hoyle 517). Now the circumscription of *S. capitata* is enlarged to include specimens previously identified as *S.* sp. Shark Bay (M.E. Trudgen 7429). *Scholtzia* sp. Shark Bay (M.E. Trudgen 7429) is a variant known from only a few, mostly poor specimens from the north-western part of the range of the complex. It tends to have narrower leaves than the other variants, often with the blade narrowly obovate, but broader leaves can be present on the same specimens. Leaf width varies considerably in the remainder of the complex, often with considerable variation on individual specimens that may occasionally include narrowly obovate leaves.

Foliar colleters are more conspicuous in this species than in most other species that have one ovule per loculus, but are usually shed before the leaves mature. Similar filiform colleters are associated with the bracts and bracteoles; these are commonly noticeable, especially if they are left protruding from the top of peduncles after the bracts and fruits have been shed.

The very isolated Stratton collection (*F. Hort & J. Hort* 3797: PERTH) occurs more than 350 km south of the known natural range of *S. capitata*. It also differs from the rest in having only 4–6 stamens per flower. It may represent a naturalised occurrence since over 500 plants have been recorded in a dense population, in which case it could be a cultivated hybrid. Alternatively the specimen could be the sole representative of a new taxon.

Scholtzia chapmanii Trudgen ex Rye, *sp. nov.*

Typus: 0.8 km E of Lake Indoon entrance along Leeman–Eneabba road, Western Australia, 9 December 1992, *R.J. Cranfield & P.J. Spencer* 8705 (*holo*: PERTH 02934256; *iso*: AD, CANB, K, MEL, NSW).

Scholtzia chapmanii Trudgen ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Winchester (C. Chapman s.n. PERTH 05625386), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub ± prostrate, 0.1–0.3 m high, commonly 0.8–1.8 m wide, at least sometimes with multiple, close branches arising at ground level from a woody base; flowering branchlets with peduncles borne at up to 20 consecutive nodes but usually at 3–12 nodes, often in a one-sided raceme-like arrangement. *Leaves* appressed or antrorse. *Petioles* absent or up to 0.4 mm long. *Leaf blades* narrowly obovate or oblong to linear in outline, 1.2–3 mm long, 0.5–1.0 mm wide, 0.4–0.7 mm thick, ciliolate or denticulate at first, the cilia up to 0.2 mm long; abaxial surface raised and somewhat flattened at centre, with lateral veins obscure, the oil glands in 1 or sometimes 2 main rows on each side of midrib, with 3–6 glands in innermost rows. *Peduncles* 1–3.5 mm long, 0.2–0.35 mm wide, 1(2)-flowered; secondary axis (when present) *c.* 0.8 mm long. *Bracteoles* 0.7–2 mm long, deciduous. *Pedicels* 0.3–1.5 mm long. *Flowers* 5–8 mm diam. *Hypanthium* 1.0–1.3 mm long, 5-ribbed. *Sepals* broadly ovate to almost semicircular, usually very broadly ovate, 1.1–1.9 mm long, ridged on the herbaceous base, the ridge usually very prominent; scarious or petaline margin 0.5–0.7 mm deep, ± entire. *Petals* 2–3.5 mm long, white or pale pink, very erect in fruit. *Stamens* 15–20, in a continuous circle. *Longest filaments* 1.5–2 mm long. *Anthers* 0.3–0.5 mm long. *Ovary c.* 1/2 inferior, 2-locular; ovules 2 per loculus. *Style* 1.5–2.3 mm long; stigma capitate (possibly sometimes slightly peltate). *Fruits c.* 1/2 inferior, 1.6–2.3 mm long, 1.8–2.2 mm wide, 5-ribbed; sepals erect; petals persistent. *Seeds* mostly 1.1–1.4 mm long, 0.6–0.8 mm wide.

Diagnostic features. Among the species with two ovules per loculus and mostly to consistently 1-flowered peduncles, *S. chapmanii* is distinguished by its 5-ribbed hypanthium. Other important characters: stamens 15–19, in a continuous circle; style 1.5–2.3 mm long.

Selected specimens examined. WESTERN AUSTRALIA: cement crossing, 1 mile [1.6 km] second road towards N Eneabba, 8 Nov. 1970, *A.C. Burns* 63 (PERTH); 8 miles [13 km] SW of Winchester, Nov. 1975, *C. Chapman s.n.* (BRI, PERTH); N side of Brand Hwy, NW of Arrowsmith River, N of Eneabba, 29 Sep. 1992, *E.A. Griffin* 6834 (MEL, PERTH); S side of Dookanooka Rd, *c.* 800 m W of Wilton Well Rd, SW of Three Springs, 14 Nov. 2004, *M. Hislop & A. Tinker* MH 3361 (PERTH); 34 km N of Eneabba on Brand Hwy, 11 Oct. 1982, *K.H. Rechinger* 58630 (W); UCL *c.* 15 km S of Mt Adams Rd, 5 km E of Brand Hwy, *c.* 40 km S of Dongara, 6 Nov. 2007, *B. Taylor & K. Greenacre* 07-66-01(PERTH); Site 110, Beekeepers Reserve, 19 Oct. 1984, *R.T. Wills* 0294 (PERTH).

Distribution and habitat. Extends from near Lake Indoon east to near Winchester (Figure 2A), in a variety of sandy habitats, sometimes over limestone or associated with winter-wet depressions, often dominated by *Banksia*.

Phenology. Flowers mainly from late September to December. Mature fruits recorded from mid October to January.

Conservation status. Not listed by Smith and Jones (2018); this species is known from two reserves and is not currently considered to be at risk.

Etymology. Named after Charles Chapman (1904–1988), a farmer who lived near Winchester and collected extensively in the area between Green Head and Coorow, including making a collection of *S. chapmanii*.

Affinities. This species, *S. prostrata* Rye and *S. quindecim* Rye make up the *S. chapmanii* complex. *Scholtzia chapmanii* differs from the other two species in having more pronounced ridges on the calyx, and usually an obviously 5-ribbed hypanthium. All three taxa seem to be geographically separated from one another. The *S. chapmanii* complex is similar to *S. teretifolia* Benth., which has even more pronounced calyx ribs. See notes under *S. prostrata*, which shows the greatest similarities to *S. chapmanii*.

Notes. One specimen, *A.C. Burns* 63, has multiple, close branches arising at ground level from a woody base of about 15 mm diameter, but no other specimens have the base attached. Another specimen, *V. Westcott s.n.*, seems atypical as it does not have obvious ribs on the hypanthium, but it is mainly in bud.

Fertile fruits often appear to have four chambers (two per loculus) when mature, these corresponding with the four ovules, with a seed produced in either a top or basal chamber. The seed tends to be somewhat oblique if in the upper chamber but more erect and occupying closer to a full loculus if in the lower chamber.

Scholtzia cordata Trudgen ex Rye, *sp. nov.*

Typus: Kalbarri National Park, Western Australia [precise locality withheld for conservation reasons], 24 October 1995, *M.N. Lyons* 2413 (*holo*: PERTH 05002273; *iso*: CANB, MEL).

Scholtzia cordata Trudgen ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 401 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Yuna (C.A. Gardner 14286), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub low-growing, 0.2–0.8 m high, 1.8–3.0 m wide; flowering branchlets with peduncles borne at 1–4 consecutive nodes in a very loose, raceme-like arrangement or an umbel-like arrangement. *Leaves* ± patent (widely antrorse to widely retrorse). *Petioles* 0.2–0.6 mm long. *Leaf blades* very broadly orbicular or cordate, 2.2–4.0 mm long, 2.5–4.2 mm wide, usually with a pale or translucent margin less than 0.1 mm deep, entire; abaxial surface rather uniformly raised, often with a narrow ridge along the midvein, with lateral veins obscure, the oil glands in at least 3 main rows on each side of midvein but inconspicuous. *Peduncles* 7–18 mm long, 0.4–0.7 mm wide, 5–20-flowered; secondary axes up to 2 mm long. *Bracts* 1.4–2.0 mm long, deciduous. *Pedicels* 0.2–0.4 mm long. *Flowers* 4.5–5.5 mm diam. *Hypanthium* 1.5–1.6 mm long, somewhat rugose or smooth. *Sepals* mostly broadly to depressed ovate or semicircular, 0.4–0.6 mm long, sometimes shortly auriculate, the outer ones with a somewhat ridged herbaceous base; petaline margin 0.3–0.5 mm deep, entire. *Petals* 1.5–2.5 mm long, white. *Stamens* 9–12, with 1–3 opposite each sepal. *Longest filaments* 0.4–0.6 mm long. *Anthers* 0.35–0.5 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.8–1.4 mm long; stigma capitate. *Fruits* *c.* 2/3 inferior, 1.9–2.3 mm long, *c.* 1.5 mm wide; sepals erect; petals deciduous but often persistent on young fruits. *Seeds* (only 1 seen) *c.* 1.5 mm long, *c.* 0.5 mm wide.

Diagnostic features. Distinguished by the following combination of characters: leaf blades very broadly orbicular or cordate; peduncles 5–20-flowered, 7–18 mm long; stamens 9–12 with 1–3 opposite each sepal; ovules 2 per loculus; style 0.8–1.4 mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 Oct. 2004, *G. Cassis, M. Wall, C. Symonds & C. Weirauch* 9-76 (PERTH); 20 Dec. 1962, *C.A. Gardner* 14286 (PERTH); 25–28 Nov. 1996, *T.F. Houston* 915-5 (PERTH); 4 Oct. 2003, *Wildflower Society of W.A.* EURA 13 (PERTH).

Distribution and habitat. Occurs from northern Kalbarri National Park south-east to north of Yuna (Figure 2B), recorded in yellow sand on dune ridges and in swales.

Phenology. Flowers mainly in October and November. Mature fruits recorded from October to December.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Previously listed (Smith & Jones 2018) as Priority One under the name *S.* sp. Yuna (C.A. Gardner 14286), but now known from more localities including a national park.

Etymology. Derived from the Latin *cordatus* (cordate), in reference to the heart-shaped leaves.

Vernacular name. Heart-leaved Scholtzia.

Affinities. Similar to *S. uberiflora* in most of the diagnostic characters listed above, but that species has more numerous flowers per branchlet, and a shorter style, 0.45–0.8 mm long. *Scholtzia uberiflora* also has longer leaves and usually fewer stamens.

Notes. Seeds are probably up to 1.9 mm long but the single mature seed seen in the current study was only 1.5 mm long.

Scholtzia corrugata Rye, *sp. nov.*

Typus: Coburn Station, Western Australia [precise locality withheld for conservation reasons], 30 August 2012, *N. Murdock* NM 031 (*holo*: PERTH 08587221; *iso*: CANB, K, MEL).

Scholtzia sp. Coburn (N. Murdock NM 031), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 May 2018].

Shrub erect, commonly 1.5–1.7 m high, width not recorded; flowering branchlets with peduncles borne at 1–4 consecutive nodes, with flowers often in a terminal globular cluster. *Leaves* appressed or antrorse. *Petioles* 0.3–0.4 mm long. *Leaf blades* ± broadly obovate, 1.5–2.5 mm long, 1.3–2.1 mm wide, entire, usually not apiculate; abaxial surface flattened at the centre in basal half to 3/4 of its length and ridged distally, with lateral veins obscure, the oil glands in 1 or 2 main rows on each side of midvein, with 4–6 glands in innermost rows. *Flowers c.* 4 mm diam. *Peduncles* 3–4.5 mm long, 0.25–0.4 mm wide, mostly 3–7-flowered; secondary axes 0.3–0.7 mm long. *Bracts* 0.6–1.4 mm long, deciduous. *Pedicels* 0.2–0.5 mm long. *Flowers c.* 4 mm diam. *Hypanthium* 1.2–1.4 mm long, reticulate-rugose or wrinkled-rugose. *Sepals* very broadly or depressed ovate, 0.35–0.5 mm long, ridged on herbaceous base; petaline margin 0.2–0.3 mm deep, entire. *Petals* 1.3–1.6 mm long, pink or white. *Stamens* commonly 5, with 0–2 opposite each sepal. *Longest filaments* 0.3–0.4 mm long. *Anthers* 0.2–0.25 mm long. *Ovary* inferior, 3-locular; ovules 1 per loculus. *Style* 0.55–0.6 mm long; stigma capitate or peltate. *Fruits c.* 3/4 inferior, *c.* 1.6 mm long, *c.* 1.5 mm wide; sepals strongly incurved; petals deciduous. *Seeds* (not fully mature) *c.* 1.4 mm long, *c.* 0.9 mm wide.

Diagnostic features. Among the species that have a 3-locular ovary with 1 ovule per loculus, *S. corrugata* is distinguished by the following combination of characters: leaves broadly obovate; peduncles 3–4.5 mm long, mostly 3–7-flowered; hypanthium reticulate-rugose or wrinkled-rugose; petals 1.3–1.6 mm long; stamens *c.* 5.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 4 Aug. 2005, *S. Chalwell* SC 73 (PERTH); 4 Aug. 1996, *G.J. Keighery & N. Gibson* 1980 (AD, BRI, MEL, PERTH); 30 July 1996, *G.J. Keighery & N. Gibson* 2055 (CANB, NSW, PERTH); 28 Aug. 2012, *D. Panickar* DP 006 (PERTH).

Distribution and habitat. Occurs from Coburn south to southern Zuytdorp Cliffs (Figure 2B), one record from yellow sand over limestone, two records from red sand with *Acacia rostellifera*.

Phenology. Flowers from July to September, with fruits recorded in August and September.

Etymology. From the Latin *corrugatus* (wrinkled, irregularly crumpled, creased), in reference to the wrinkled hypanthium.

Conservation status. Recently listed as Priority Two under Conservation Codes for Western Australian Flora. Currently known from five locations, possibly including a nature reserve (Cooloomia Nature Reserve).

Affinities. *Scholtzia corrugata* is very similar to *S. calcicola*, which has narrower leaves and smaller flowers (with a shorter hypanthium and petals) and occurs further south.

Notes. Good fruiting material is still needed for this species. A few apparently full-sized fruits are present on the type collection, and the most mature seed seen was measured.

Scholtzia denticulata Rye, *sp. nov.*

Typus: Murchison River Gorge, Kalbarri National Park [precise locality withheld for conservation reasons], Western Australia, 6 October 1990, *S. Maley* 6 (*holo*: PERTH 03627969; *iso*: CANB, K, MEL, NSW).

Scholtzia sp. Ross Graham Lookout (S. Maley 6), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Murchison River (A.S. George 7098), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Murchison River (A.S. George 7908), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018] – collection number wrong previously.

Shrub 0.8–2.0 m high, 1.0–2.5 m wide; flowering branchlets with peduncles borne at 1–5 consecutive nodes, commonly in a raceme-like arrangement well below the apex of branchlet but sometimes the flowers in more globular clusters. *Leaves* antrorse to patent. *Petioles* 0.5–1.1 mm long. *Leaf blades* linear or narrowly obovate to ± circular, 4–8.5 mm long, 0.7–3.3(–4.5) mm wide, uniformly unthickened, denticulate to ciliolate, with incurved or infolded margins; abaxial surface with lateral veins obscure, the oil glands crowded in (2)3 or more main rows on each side of midvein but inconspicuous. *Peduncles* 1.5–6 mm long, 0.4–0.6 mm wide, mostly 3–15-flowered; secondary axes 0.5–1.0 mm long. *Bracts* 1.3–3.1 mm long, persistent in flower but deciduous in late flower, broad, denticulate-laciniate. *Pedicels* up to 1.1 mm long. *Flowers* (5–)5.5–7.5 mm diam. *Hypanthium* 1.0–1.6 mm long, rugose. *Sepals* ovate or broadly ovate, (1.3–)1.5–2.5 mm long, scarious throughout, not or scarcely ridged at base, denticulate. *Petals* 2–3 mm long, white or pink. *Stamens* 8–11, with 1–3 opposite each sepal. *Longest filaments* 0.6–1.0 mm long. *Anthers* 0.35–0.45 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* commonly 0.8–1.1 mm long; stigma capitate. *Fruits c.* 3/4 inferior, probably *c.* 2 mm long; sepals erect to strongly recurved; petals apparently deciduous.

Diagnostic features. Among species that have a 2-locular ovary with 2 ovules per loculus, *S. denticulata* is distinguished by the following combination of characters: leaf blades 4–8.5 mm long, denticulate to ciliolate; peduncles 1.5–6 mm long, mostly 3–15-flowered; persistent bracteoles; sepals (1.3–) 1.5–2.5 mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 10 Oct. 1995, *D. & B. Bellairs* 3003 (PERTH); 8 Sep. 2001, *D. & B. Bellairs* 6202 (PERTH); 20 Aug. 1961, *C.A. Gardner* 13211 (PERTH); 7 Sep. 1966, *A.S. George* 7908 (PERTH); 22 Sep. 1994, *A.G. Gunness* 2379 (AD, BRI, NT, PERTH); 27 Sep. 1962, *M.E. Phillips* WA/62 1447 (CBG, PERTH).

Distribution and habitat. Recorded along the gorges of the Murchison River and in nearby areas within Kalbarri National Park (Figure 3B), in sand, mostly from sandstone well above the river, in sites described as rocky or sloping sandplain.

Phenology. Flowers from August to November.

Etymology. From the Latin *denticulatus* (bearing small teeth), referring to the minutely toothed margins to the leaves, bracts and sepals.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Listed with this conservation status by Smith and Jones (2018) under the name *S.* sp. Ross Graham Lookout (S. Maley 6). All known populations occur in a large national park.

Co-occurring species. Recorded (*A.G. Gunness* AG 2379) growing downslope from, but apparently not intermixed with, *S. longipedata* (*A.G. Gunness* AG 2382).

Affinities. This species does not appear to be particularly close to any other named species. It differs from other species in the latter part of the key (lead 43 onwards), such as *S. oligandra* F.Muell. ex Benth., in having more persistent bracteoles and longer sepals.

Notes. *Scholtzia denticulata* usually has the longest sepals in relation to petals in the genus, typically about 3/4 the length of the petals but sometimes more or less as long as the petals. However, the name *S.* sp. Murchison River (A.S. George 7908) has been applied to a single collection that has somewhat shorter sepals than usual, the largest ones 1.3–1.5 mm long. It also appears a little different from other specimens because it is at a more advanced stage of flowering. A sterile fruit observed on *A.S. George* 7908 is *c.* 2 mm long and 1.8 mm wide. No other specimens have any mature fruits.

Scholtzia halophila Rye, *sp. nov.*

Typus: 3 miles [5 km] west of Coomberdale, Western Australia, 6 October 1976, *M.E. & M.E. Trudgen* MET 1724 (*holo*: PERTH 06171893; *iso*: CANB, K, MEL, NSW).

Shrub 0.5–3(–4) m high, 1.7–4(–5) m wide; flowering branchlets with peduncles borne at 2–6 consecutive nodes, often with flowers in a loose globular cluster. *Leaves* antrorse to somewhat retrorse, usually widely antrorse or patent. *Petioles* 0.3–0.7 mm long. *Leaf blades* broadly or very broadly obovate, 1.7–4.0 mm long, 1.7–3.8 mm wide, entire (occasionally some young leaves denticulate distally); abaxial surface not raised except sometimes narrowly along centre, sometimes grooved along midvein in lower part and ridged above, with lateral veins obscure or sometimes with 4–6 veins visible on each side of midvein, the oil glands in 1(–3) main rows on each side of midvein, with 3–5(–7) glands in innermost rows. *Peduncles* 3.5–14 mm long, 0.25–0.55 mm wide, 3–9(–12)-flowered; secondary axes ± absent or up to 0.8 mm long. *Bracts* 1.6–2.3 mm long. *Pedicels* 0.3–1.4 mm long. *Flowers* 4.0–5.5 mm diam. *Hypanthium* 1.4–1.5 mm long, rugose-pitted. *Sepals* broadly or very broadly ovate, 0.5–1.4 mm long, fully scarious or outermost ones ridged at base and with a deep petaline margin, entire. *Petals* 1.6–2.7 mm long, white or pink. *Stamens* 5–12, with 0–3 opposite each sepal. *Longest filaments* 0.3–0.6 mm long. *Anthers* 0.25–0.3 mm long. *Ovary* inferior, usually 2- or 3-locular (rarely 4-locular in one subspecies); ovules 1 per loculus. *Style* 0.7–1.4 mm long; stigma ± peltate. *Fruits c.* 1/2 inferior, 1.4–1.8 mm long, 1.8–2.3 mm wide; sepals incurved to spreading; petals deciduous. *Seeds* 1.0–1.2 mm long, 0.6–0.7 mm wide. (Figure 1C)

Diagnostic features. Among the species that have 1 ovule per loculus, *S. halophila* is distinguished by the following combination of characters: petioles 0.3–0.7 mm long; peduncles 3.5–14 mm long, 3–12-flowered; hypanthium rugose-pitted; stamens 5–12; ovary 2–4-locular; style 0.7–1.4 mm long.

Distribution and habitat. Extends from near Coorow south-east to near Tammin (Figure 4), associated with salt lakes and on saline margins of watercourses.

Phenology. Flowers mainly from September to November. Fruits recorded from October to February.

Etymology. From the Greek *halos* (salt) and *-philios* (loving), referring to the species' habitat surrounding salt lakes.

Vernacular name. Saltlands Scholtzia. This species occurs on the margins of salt lakes (or on raised areas within salt lakes) and on the somewhat saline margins of inland watercourses.

Co-occurring species. Since *S. halophila* occurs in more saline habitats than other species of *Scholtzia*, it does not appear to grow intermingled with them. However, it overlaps in range with *S. parviflora* F.Muell. and *S. uniovulata* Rye, both of which have sometimes been recorded not far from salt lakes.

Affinities. Similar to *S. parviflora* and *S. uniovulata* in many respects, such as having a pitted hypanthium, but differs in having more numerous flowers (3–12 *cf.* 1–3) on longer peduncles (3.5–14 mm *cf.* 0.7–3.5 mm), more numerous stamens (5–12 *cf.* usually 3–5) and a minimum of two loculi in the ovary (*cf.* 1- or 2-locular).

Notes. Stamens are often in very discrete groups in *S. halophila*, i.e. with the stamens of each antisepalous group very close (see Figure 1B), whereas some other species have the stamens often widely separated opposite each sepal.

Three geographically separated subspecies are recognised. These have previously been treated, informally, as separate species, but the morphological differences between them are only minor.

a. Scholtzia halophila Rye subsp. **halophila**

Scholtzia sp. Coomberdale (M.E. & M.E. Trudgen MET 1724), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Leaf blades 1.7–3.5(–4) mm long, 1.7–3.3 mm wide. *Peduncles* 5–14 mm long. *Sepals* largely scarious or petal-like, 0.5–0.7 mm long. *Petals* 1.8–2.3 mm long. *Stamens* 7–12, with usually 1–3 opposite each sepal. *Longest filaments c.* 0.4 mm long. *Ovary* 2- or 3-locular. *Style* 0.8–1.4 mm long.

Diagnostic characters. Distinguished from subsp. *meridionalis* Rye by its more numerous stamens and longer peduncles. Distinguished from subsp. *mortlockensis* Rye primarily by its shorter sepals and in often having 2-locular ovaries.

Selected specimens examined. WESTERN AUSTRALIA: Stacy property, 14.5 km down Buntine–Marchagee Rd from the Midlands Rd intersection at Marchagee, adjacent Nature Reserve R28669, 1 Dec. 2009, *A. Chant* 1059 (PERTH); 15 km E of Marchagee on Buntine–Marchagee Rd, 2.5 km W

of Mamboobie Rd, 15 Nov. 1990, *S. Patrick* 501 (PERTH); Lake Eganu, *c.* 35 km S of Carnamah, 17 Sep. 2001, *A. Webb & B. Muir* 267 (PERTH).

Distribution. Extends from near Coorow south to the Wongan Hills area and apparently also in the Tammin area (Figure 4A). Two PERTH specimens from the Tammin area (*T.E.H. Aplin* 612; *A.M. Lyne* 956, *L. Craven & F. Zich*) are tentatively paced under this subspecies.

Conservation status. Not listed by Smith and Jones (2018); this taxon is known from a national park and a nature reserve and is not currently considered to be at risk.

Notes. The excluded syntype of *S. capitata*, *J. Drummond 134* (MEL 2278623, K 000357122 & 000357123), appears to match this subspecies.

Of the three subspecies, *halophila* tends to have the longest peduncles, probably also the greatest tendency for its leaves to show veining, and is unusual in that some specimens have about equal numbers of 2- and 3-locular ovaries. See under the other subspecies for further differences.

b. Scholtzia halophila subsp. **meridionalis** Rye, *subsp. nov.*

Typus: Shire of Quairading, Western Australia [precise locality withheld for conservation reasons], 12 October 2002, *A.G. Gunness* 2828 (*holo*: PERTH 08245517; *iso*: CANB, MEL).

Scholtzia sp. Yenyening Lakes (A. Gunness 2824), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Leaf blades 1.8–2.5 mm long, 2.0–2.5 mm wide. *Peduncles* 3.5–6.5 mm long. *Sepals* mostly very broadly ovate, scarious or petal-like, 0.8–1.2 mm long. *Petals* 1.8–2.1 mm long. *Stamens* 5–8, with 0–2 opposite each sepal. *Longest filaments* 0.3–0.4 mm long. *Ovary* 2-locular. *Style* 0.7–1.1 mm long.

Diagnostic features. Subsp. *meridionalis* is distinguished from the other two subspecies by the following combination of characters: peduncles 3.5–6.5 mm long; stamens 5–8; ovary 2-locular.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 18 Sep. 2002, *A.G. Gunness* 2821 (AD, BRI, K, NSW, PERTH); 17 Sep. 2002, *T. Watson* 279 (PERTH).

Distribution and habitat. Associated with salt lakes in Yenyening Lakes Nature Reserve (Figure 4A), on white or yellow sand.

Phenology. Flowers mainly from September to November. Fruits recorded in November and July.

Etymology. From the Latin *meridionalis* (southern), as this subspecies occurs in the far south of the distribution of the genus.

Conservation status. Recently listed as Priority Two under Conservation Codes for Western Australian Flora. This species is known from a conservation reserve.

Notes. The sepals of this subspecies tend to be intermediate in length between those of subspecies *halophila* and *mortlockensis* but show some overlap with both of them. Subsp. *meridionalis* also

usually has fewer stamens (5–8 *cf.* 7–12), and its mature style tends to be shorter (0.7–1.1 *cf.* 0.8–1.4 mm long). However, good fruiting material is absent in subsp. *meridionalis* and this is needed to determine whether the mature style is sometimes close to the maximum length recorded for the other two subspecies.

c. Scholtzia halophila subsp. **mortlockensis** Rye, *subsp. nov.*

Typus: Mortlock River, Western Australia, 18 November 1986, *M.E. Trudgen* 5427 (*holo*: PERTH 06171877; *iso*: CANB, K, MEL, NSW).

Scholtzia sp. Duck Pool (M.E. Trudgen MET 5427), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Leaf blades 2.5–4.0 mm long, 2.0–3.6 mm wide. *Peduncles* 4–8 mm long. *Sepals* broadly or very broadly ovate, petal-like, 1.0–1.4 mm long. *Petals* 2.3–2.5 mm long, white to medium pink. *Stamens* (6–)8–11, with 0–3 opposite each sepal. *Longest filaments* 0.4–0.6 mm long. *Ovary* usually 3-locular (rarely with a proportion of them 4-locular). *Style* 1.1–1.3 mm long.

Diagnostic features. Subspecies *mortlockensis* is distinguished from the other two subspecies by the following combination of characters: sepals 1–1.4 mm long; stamens (6–)8–11; ovary 3-locular in most flowers.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 Jan. 1946, *C.A. Gardner s.n.* (BRI, CANB, NSW, PERTH); 26 Nov. 2003, *B. Oversby* BO 142 (PERTH); 23 Oct. 1967, *P.G. Wilson* 6394 (AD, PERTH).

Distribution. Occurs along the Mortlock River North, Mortlock River South and Mortlock River East, extending from north of Northam inland to near Cunderdin (Figure 4B).

Etymology. Refers to its occurrence along all three branches of the Mortlock River, combining Mortlock with the Latin *-ensis* (native of).

Conservation status. Recently listed as Priority Three under Conservation Codes for Western Australian Flora. Only known from 15 collections, some of which are historical records, in habitat that is susceptible to hydrological changes and salinity. Further survey is needed to check the conservation status of this taxon.

Notes. This subspecies is intermediate in its average latitude and peduncle length between the other two subspecies. While it is readily separated in both morphology and distribution from subsp. *meridionalis*, it shows a greater approach in both these aspects to subsp. *halophila*. The length of its largest sepal is the character that best separates it from subsp. *halophila* (1–1.4 mm *cf.* 0.5–0.8 mm long), but there may be some intermediate specimens occurring in the region where the ranges of the two taxa more or less meet.

Subsp. *mortlockensis* is distinguished from subsp. *meridionalis* in having the ovary 3-locular rather than 2-locular in a majority of the flowers, and is the only subspecies known to rarely have a 4-locular ovary. At least one PERTH specimen, *C. Howell* 494, has a number of 4-locular ovaries, a character state not recorded elsewhere in the genus.

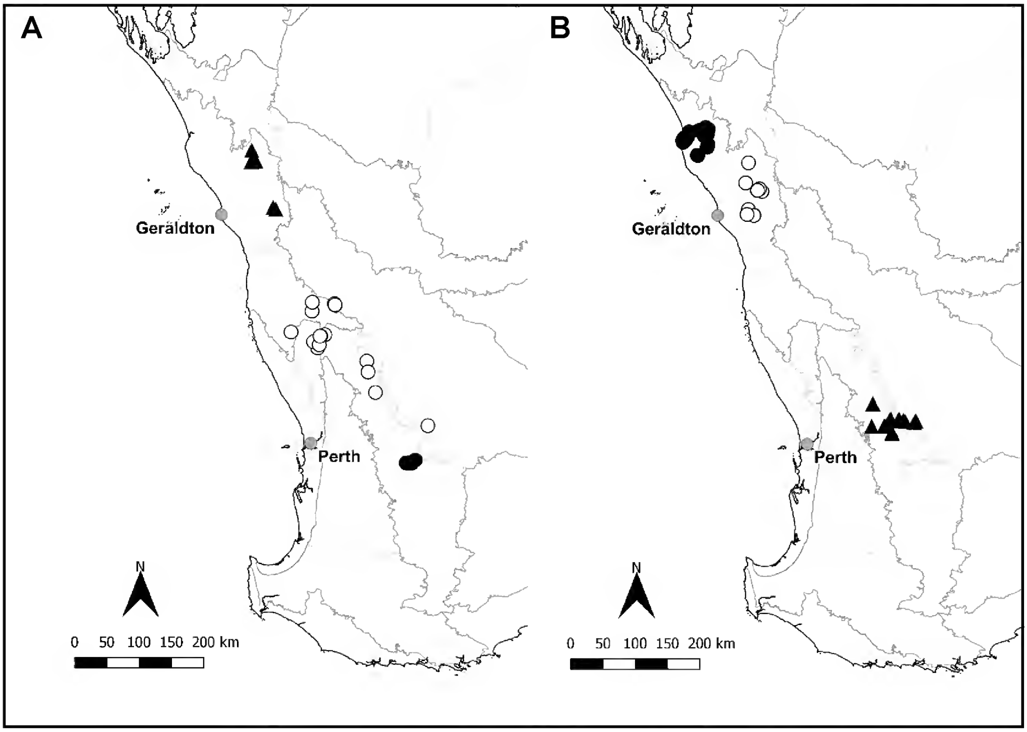

Figure 4. Distribution of *Scholtzia* species and subspecies. A – *S. halophila* subsp. *halophila* (○), *S. halophila* subsp. *meridionalis* (●) and *S. uniflora* (▲); B – *S. halophila* subsp. *mortlockensis* (▲), *S. longipedata* subsp. *longipedata* (●) and *S. longipedata* subsp. *procera* (○).

Scholtzia inaequalis Rye, *sp. nov.*

Typus: East Yuna Nature Reserve, Western Australia [precise locality withheld for conservation reasons], August 1985, *T.F. Houston* 617-2 (*holo*: PERTH 03627721; *iso*: CANB).

Scholtzia sp. East Yuna (A.C. Burns 6), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 1–3 m high, 0.5–3 m wide; flowering branchlets with 1–4(–6) pairs of peduncles, often with flowers in a dense cluster or short raceme-like arrangement. *Leaves* appressed or antrorse. *Petioles* 0.2–0.5 mm long. *Leaf blades* obovate or broadly obovate, 1.0–2.5 mm long, 1.0–1.7 mm wide, entire, often apiculate; adaxial surface flattened at the centre in basal 1/2–3/4 of its length and ridged distally, with lateral veins obscure, the oil glands in 1 main row of 3 or 4 large glands and 1 or 2 rows of smaller glands on each side of midvein. *Peduncles* 0.4–1.2(–1.7) mm long, 0.3–0.5 mm wide, 1–3-flowered; secondary axes ± absent. *Bracts* 0.8–2.0 mm long. *Pedicels* 0.2–0.8 mm long. *Flowers* 4–5 mm diam. *Hypanthium* 0.7–1.2 mm long, wrinkled-rugose. *Sepals* greatly differing in size and sometimes orientation, the outermost one broadly or very broadly ovate and 0.35–0.5 mm long and the innermost one broadly to depressed ovate and 0.8–1.4 mm long, the base ridged; petaline margin up to 0.7 mm deep, but much smaller on outermost sepals, entire. *Petals* 1.5–2.5 mm long, pale pink. *Stamens* 3–6, 0–2 opposite each sepal. *Longest filaments* 0.5–0.7 mm long. *Anthers* 0.25–0.3 mm

long. *Ovary* inferior, 2-locular in all or most flowers, rarely 3-locular; ovules 1 per loculus. *Style* 0.8–1.5 mm long; stigma peltate or capitate. *Fruits c.* 2/3-inferior, *c.* 1.5 mm long, *c.* 1.6 mm wide; sepals fairly erect or (especially outer ones) tending to be incurved; petals deciduous. *Seeds c.* 1.3 mm long, *c.* 1.1 mm wide.

Diagnostic features. Among species that have 1 ovule per loculus, *S. inaequalis* is distinguished by the following combination of characters: 1–3-flowered peduncles 0.4–1.2 mm long; petals 1.5–2.5 mm long; stamens 3–6; outer sepals (incurved), usually much shorter than inner sepals (erect); hypanthium wrinkled-rugose.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons], 12–16 Oct. 19768, *B.G. Muir* 38 6.2 (PERTH); 15 Aug. 2006, *A. Gunness* AG 2988 (MEL, PERTH); 28 Aug. 2008, *A. Gunness* AG 3004 (CANB, NSW, PERTH); 31 July 2003, *M.E. Trudgen* MET 22021 (PERTH).

Distribution and habitat. Extends from East Yuna Nature Reserve south to the Wicherina area (Figure 3B), recorded from varied habitats including the base of a low granite breakaway, lateritic and yellow sandplain areas, sometimes in open *Eucalyptus* woodlands.

Phenology. Flowers mainly from June to October. Mature fruits recorded in August.

Etymology. From the Latin *inaequalis* (unequal), referring to the usually unequally sized sepals, with the innermost sepal tending to be more erect, as well as much larger than, the outermost sepal.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Listed with this status by Smith and Jones (2018) under the name *S.* sp. *East Yuna* (A.C. Burns 6). This taxon occurs in a large nature reserve and one other reserve.

Affinities. This species is very similar to *S. truncata*, which differs in having less difference in size between the inner and outer sepals, more numerous stamens and possibly a shorter style. It is also very similar to *S. uniovulata*, which differs in having a pitted hypanthium and often only a 1-locular ovary. Both of those species overlap in distribution with *S. inequalis*.

Scholtzia inaequalis could also be confused with *S. corrugata* but that species differs in having longer, mostly 3–7-flowered peduncles and occurs further north.

Notes. Two PERTH specimens that may belong to this species but which have more uniform-sized sepals than usual are *P. Fairall* 754 and *S. Patrick* SP 1760, both from the large East Yuna Flora Reserve (PERTH).

Scholtzia laciniata Rye, *sp. nov.*

Typus: near Lancelin, Western Australia, 1975, *M.E. Trudgen* 1516 (*holo*: PERTH 06362168; *iso*: AD, CANB, K, MEL, NSW).

Scholtzia sp. Lancelin (M.E. Trudgen 1516), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Prostrate or widely spreading *shrub* up to 0.4 m high, width not recorded, with young stems often markedly tuberculate; flowering branchlets with peduncles borne at 3–15 consecutive nodes, in a raceme-like arrangement. *Leaves* widely antrorse to retrorse. *Petioles* 0.3–0.7 mm long. *Leaf blades* elliptic to broadly ovate or cordate, 2.5–4 mm long, 2–4 mm wide, markedly ciliate-laciniate, the longest cilia 0.4–0.8 mm long; abaxial surface raised only at the centre (near the midvein) and tending to be grooved along the midvein, with lateral veins obscure, the oil glands in several main rows on each side of midvein but inconspicuous. *Peduncles* 1.5–2.5 mm long, 0.4–0.7 mm wide, 3–7-flowered; secondary axes up to 0.6 mm long. *Bracts* 1.3–2 mm long, deciduous. *Longest pedicels* 0.4–0.8 mm long. *Flowers* 5–8 mm diam. *Hypanthium* 1.5–1.8 mm long, smooth or 5-ribbed. *Sepals* mostly very broadly to depressed ovate, 0.8–1.3 mm long, largely scarious, the herbaceous base somewhat ridged or almost smooth; petaline margin 0.5–0.8 mm deep, denticulate. *Petals* 2.5–3.5 mm long, pale pink. *Stamens* (10–)12–22, in a continuous circle. *Longest filaments* 1.7–2.5 mm long. *Anthers* 0.4–0.5 mm long. *Ovary* largely inferior, 2-locular; ovules 2 per loculus. *Style* 2.4–3.1 mm long; stigma capitate or peltate. *Fruits* 1/2–2/3 inferior, only sterile ones seen; sepals erect; petals deciduous.

Diagnostic features. Distinguished by the following combination of characters: young stems often markedly tuberculate; leaf blades elliptic to broadly ovate or cordate, markedly ciliate-laciniate; stamens up to 22, in a continuous circle.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 8 Dec. 1992, *E.A. Griffin* 8404 (PERTH); 25 Jan. 1966, *J.J. Havel* H 251 (PERTH); 5 Oct. 1999, *M.A. Langley & P.M. Smith* MAL 2173 (PERTH); 23 Nov. 2017, *B. Morgan* IOMH-12 (PERTH); 1 Dec. 1974, *A.E. Orchard* 4267 (PERTH).

Distribution and habitat. Extends from near Lancelin south to near Seabird and inland to Moore River National Park (Figure 5A), in shallow sand over limestone near the coast and in deep yellow sand further inland.

Phenology. Flowers from November to January. Fruits recorded from December to January.

Etymology. From the Latin *laciniatus* (laciniate), in reference to the irregularly incised leaf margins.

Vernacular name. Ragged-leaved Scholtzia.

Conservation status. Recently listed as Priority Two under Conservation Codes for Western Australian Flora, this species has a restricted range only *c.* 30 km long.

Affinities. Similar to *S. involucrata* in many respects, including having flat leaves and peduncles usually 3–7-flowered, but differing in having markedly laciniate-ciliate margins to the leaves and in having the base of the sepals somewhat ridged.

Notes. *Scholtzia laciniata* seems to be the only member of the genus to commonly have markedly tuberculate young stems. Judging from the most mature fruits examined, seeds probably tend to be 1.7–2 mm long. One PERTH specimen, *B. Morgan* IOMH-12, appeared to have most flowers with only 10–12 stamens. All other specimens examined had mostly 14–22 stamens per flower.

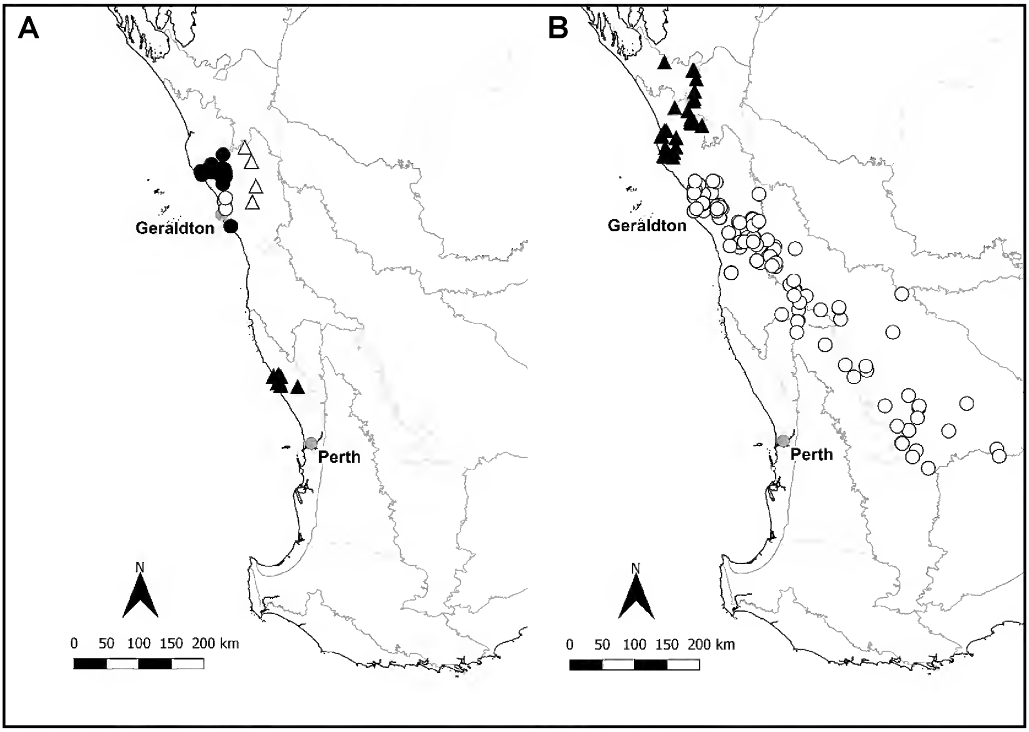

Figure 5. Distribution of *Scholtzia* species and subspecies. A – *S. laciniata* (▲), *S. pentamera* subsp. *pentamera* (●), *S. pentamera* subsp. *collina* (○) and *S. thinicola* (△); B – *S. oleosa* (▲) and *S. uniovulata* (○).

Scholtzia longipedata Rye, *sp. nov.*

Typus: 4.3 km along firebreak, *c.* 8.3 km E of Kalbarri along Ajana–Kalbarri road, Western Australia, 30 August 2001, *R. Davis* 10004 (*holo*: PERTH 05823854; *iso*: MEL).

Shrub 0.3–2.5 m high, 1–2.5 m wide; flowering branchlets with peduncles borne at 1–5 consecutive nodes, varying in arrangement, sometimes combined into an umbel-like or short raceme-like arrangement but often discrete or more densely arranged. *Leaves* antrorse to patent, usually widely antrorse. *Petioles* 0.4–1.0 mm long. *Leaf blades* obovate or broadly obovate, 2.5–4.5 mm long, 1.4–3.5 mm wide, entire, with incurved margins; abaxial surface gradually raised towards the centre, often indented or flattened along the midvein but narrowed to a ridge distally, with thin translucent margins less than 0.1 mm deep, with lateral veins obscure, the oil glands in more than 2 rows on each side of midvein but inconspicuous. *Peduncles* 6–16 mm long, 0.4–0.8 mm wide, mostly 7–21-flowered; secondary axes up to 1.5 mm long. *Basal bracts* 1.4–2.5 mm long, caducous or deciduous. *Pedicels* 0.3–1.0 mm long. *Flowers* 3.5–5.5 mm diam. *Hypanthium* 1.0–1.6 mm long, somewhat rugose. *Sepals* broadly to depressed ovate, 0.3–0.75 mm long, smooth or with a basal ridge; petaline margin 0.2–0.3 mm deep, entire. *Petals* 1.3–2 mm long, white or pink. *Stamens* 6–9, with 1–3 opposite each sepal (commonly 8 in the arrangement 2,1,2,2,1). *Longest filaments* 0.4–0.6 mm long. *Anthers* 0.25–0.35 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.7–1.4 mm long. *Fruits c.* 3/4 inferior, commonly 1.9–2.3 mm long, 1.6–1.7 mm wide; sepals erect; petals persistent or deciduous. *Seeds* 1.2–1.6 mm long, 0.5–0.7 mm wide.

Diagnostic features. Among species that have a 2-locular ovary with 2 ovules per loculus, *S. longipedata* is distinguished by the following combination of characters: leaf blades entire, obovate or broadly obovate; petioles 0.4–1 mm long; peduncles 7–16 mm long, mostly 7–21-flowered; sepals 0.3–0.75 mm long; stamens 6–9, with 1–3 opposite each sepal.

Distribution and habitat. Extends from the coast of the northern part of Kalbarri National Park south-east to East Yuna Reserve and Eradu (Figure 4B).

Phenology. Flowers mainly from July to November but with one record from December. Mature fruits have been recorded from September to November.

Etymology. From the Latin *longus* (long), *pes* (*-pedis*; foot) and *-atus* (indicating possession or likeness), referring to the long peduncles in this species. *Scholtzia spatulata* has the longest peduncles in the genus, but also tends to have longer leaves, so the two taxa are similar in the degree to which the flowers are separated from the foliage. Another particularly long-pedunculate species is *S. cordata*.

Co-occurring species. Recorded (*A.G. Gunness* AG 2382) growing upslope from, but apparently not intermixed with, *S. denticulata* (*A.G. Gunness* AG 2379).

Affinities. All other species of *Scholtzia* differ in several characters from this species, making it difficult to suggest which might be its closest relative.

Notes. This species was first collected in 1958 'near the Murchison River' by Charles Gardner, who recorded the plant height as '30 cm' and flowering in early December. These details, if accurate, give the lowest plant height and latest flowering time recorded for the species.

Two subspecies are recognised, occurring in the north and south of the range respectively.

a. Scholtzia longipedata subsp. **longipedata**

Scholtzia sp. Red Bluff (A. Gunness 2373), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 0.3–2.4 m high, 1.0–2.5 m wide. *Leaf blades* 2.5–4.5 mm long, 1.4–3.5 mm wide, not very thick. *Peduncles* 7–16 mm long. *Sepals* usually depressed ovate, 0.3–0.5 mm long, smooth or with a basal ridge; petaline margin 0.2–0.3 mm deep. *Style* 0.7–1.4 mm long; stigma peltate or capitate.

Selected specimens examined. WESTERN AUSTRALIA: Transect RB, Red Bluff, Kalbarri National Park, 9 Sep. 2003, *D. & B. Bellairs* 6336 (PERTH); Erriary Rd, 8.4 km N of the intersection with Binnu West Rd, 9 July 1997, *R. Davis* 3674 (PERTH); between Lookout and parking lot, Z Bend, Murchison River gorge, Kalbarri National Park, 2 Oct. 1991, *W. Greuter* 22482 (PERTH); Pot Alley Gorge, Kalbarri National Park, 26 Sep. 1974, *G. Perry* 322 (CANB, MEL, PERTH); 33.5 km E of the Meanarra Hill turnoff on the road to North West Coastal Hwy, Kalbarri National Park, 25 Sep. 2002, *M.E. Trudgen* 21708 (AD, BRI, CANB, DNA, NSW).

Distribution and habitat. Occurs in Kalbarri National Park and just south of the park (Figure 4B), on the coast in sand over sandstone and in near-coastal areas with sand.

Conservation status. Not listed by Smith and Jones (2018); most of the range of this species is within a large national park.

Notes. Specimens collected from along the coast are mostly 0.3–1.5 m high, apparently stunted from their exposed position, whereas those collected further inland are 1.2–2.5 m high. There is ample flowering material but better fruiting material is needed for this subspecies.

The stigma is often peltate in subsp. *longipedata* but is always capitate in subsp. *procera* Rye. See under the latter for other differences.

b. Scholtzia longipedata subsp. **procera** Rye, *subsp. nov.*

Typus: Binnu East Road, Western Australia [precise locality withheld for conservation reasons], 6 December 1993, *M.E. Trudgen & M.R. Trudgen* MET 12016 (*holo*: PERTH 06171869; *iso*: AD, BRI, CANB, K, NSW, MEL).

Scholtzia sp. Binnu-Yuna (M.E. Trudgen 12016), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Eradu (R.D. Royce 8016), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 1.2–3.5 m high, commonly 1–1.7 m wide. *Leaf blades* 2.0–3.3 mm long, 1.5–3.0 mm wide, up to *c.* 0.4 mm thick. *Peduncles* 6–11 mm long. *Sepals* broadly or very broadly ovate, (0.4–)0.5–0.75 mm long, with herbaceous base distinctly ridged; petaline margin 0.25–0.5 mm deep. *Style* 0.5–1.0 mm long; stigma capitate.

Diagnostic features. Differs from subsp. *longipedata* in its usually thicker leaves and usually longer sepals that are more markedly ridged, and tends to be a taller plant with more persistent petals and a shorter style.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 19 Nov. 1968, *A.C. Burns* 99A (PERTH); 24 Oct. 1992, *E.A. Griffin* 7516 (PERTH); 15 Aug. 2008, *A. Gunness* AG 2987 (PERTH); 24 Oct. 2001, *S.J. Patrick* 4082 (PERTH); 31 Oct. 1963, *R.D. Royce* 8016 (PERTH); 31 July 2003, *M. Trudgen* MET 22017 (PERTH); 28 Sep. 2007, *M.E. Trudgen & M. Guest* MET 22544 (PERTH).

Distribution and habitat. Extends from East Yuna Reserve south-west to Eradu (Figure 4B), in varied habitats that are usually sandy, often with mallees, *Melaleuca* or *Allocasuarina*. This subspecies may form a tall shrubland 2–3 m high.

Etymology. From the Latin *procerus* (tall, long), as this is one of the tallest members of the genus, up to 3.5 m high.

Conservation status. Priority Three under Conservation Codes for Western Australian Flora. Previously listed as Priority Two by Smith and Jones (2018) under the name *Scholtzia* sp. Eradu (R.D. Royce

8016) but not listed under the name *Scholtzia* sp. Binnu-Yuna (M.E. Trudgen 12016). This species is known from two nature reserves.

Notes. The phrase names *S.* sp. Eradu and *S.* sp. Binnu-Yuna have been applied to western and eastern specimens respectively, with all of the former in fruit and the latter mainly in bud or flower. Western specimens tend to have shorter sepals and styles than the eastern ones, but there is considerable overlap in the measurements of these characters.

Scholtzia multiflora Rye, *sp. nov.*

Typus: Burma Road, Western Australia [precise locality withheld for conservation reasons], 1 August 2003, *M. Trudgen* MET 22022 (*holo*: PERTH 08209022; *iso*: CANB, K, MEL, NSW).

Scholtzia sp. Kojarena (A.M. Ashby 1904), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub commonly 1.6–2.0 m high, recorded as 1.5–2.7 m wide; flowering branchlets mostly with peduncles at 5–42 consecutive nodes in a raceme-like arrangement. *Leaves* widely antrorse or patent. *Petioles* 0.2–0.4 mm long. *Leaf blades* ± very broadly obovate, 1.7–3.3 mm long, 2.3–3.0 mm wide, entire, obtuse, not apiculate; abaxial surface flattened at the centre in basal 1/2–3/4 of its length and with midrib ridged distally, with lateral veins obscure, the oil glands usually in 3 or more main rows on each side of midvein, with 4 or 5 glands in innermost rows. *Peduncles* 5–7 mm long, 0.2–0.3 mm wide, 3–15-flowered; secondary axes 0.4–0.7 mm long. *Bracts* 0.4–1.5 mm long. *Pedicels* absent or up to 0.3 mm long. *Flowers* 3.5–4.5 mm diam. *Hypanthium* 0.7–1.1 mm long, reticulate-rugose. *Sepals* mostly broadly or very broadly ovate, 0.4–0.5 mm long, smooth or ridged at extreme base, largely petaline, entire. *Petals* 1.4–1.6 mm long, white or pale pink. *Stamens* 4–7, with 0–2 opposite each sepal. *Longest filaments c.* 0.5 mm long. *Anthers c.* 0.2 mm long. *Ovary* inferior, 2-locular; ovules 1 per loculus. *Style* 0.6–0.7 mm long; stigma capitate or peltate. *Fruits c.* 2/3 inferior, *c.* 1.3 mm long, *c.* 1.3 mm wide; sepals incurved; petals deciduous. *Seeds* 0.65–1.1 mm long, 0.6–0.7 mm wide.

Diagnostic features. Among species that have 1 ovule per loculus, *S. multiflora* is distinguished by the following combination of characters: leaves wider than long; peduncles many-flowered 5–7 mm long, borne at usually 5–42 consecutive nodes; hypanthium reticulate-rugose; stamens 4–7.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Aug. 1966, *A.M. Ashby* 1904 (PERTH); 15 Aug. 2008, *A. Gunness* AG 2991 (PERTH); 8 Sep. 1998, *S. Patrick* 3007 (PERTH); Aug. 1924. *G.L. Sutton s.n.* (PERTH).

Distribution and habitat. Recorded from Kojarena south-east to east of Walkaway (Figure 3A), one record from a lateritic ridge but also recorded from a sandy swale. An outlying specimen from about 100 km to the south-east near Winchester, may also belong to this species (see *Notes* section below).

Phenology. Flowers recorded from July to September and mature fruits in August.

Etymology. From the Latin *multi-* (many-) and *-florus* (-flowered). This species is given the epithet *multiflora* because it has the largest number of consecutive nodes bearing flowers so far recorded in the genus, and often has numerous flowers on each peduncle.

Conservation status. Priority One under Conservation Codes for Western Australian Flora. Listed with this status by Smith and Jones (2018) under the name *S.* sp. Kojarena (A.M. Ashby 1904).

Affinities. Of the currently named species, *S. calcicola* and *S. corrugata* are perhaps the closest in their morphology, but *S. multiflora* differs from both in having widely spreading, depressed-obovate leaves with oil glands in 3 or more main rows on each side of midvein, more numerous peduncles on the flowering branchlets and a 2-locular ovary. Its fruit also appears to differ in being wider than broad and less glandular, but this requires confirmation with better fruiting material. All three species have sepals that are usually strongly incurved in flower as well as in fruit.

Notes. A single, atypical specimen (*E. Wittwer* 813: PERTH) from the Winchester area (see Figure 3A) is currently determined as *S. aff. multiflora*. This specimen might prove to be sufficiently distinctive to be treated as a subspecies of *S. multiflora* or a separate species but is too poorly known to assess its taxonomic status. The Winchester collection differs in having shorter peduncles (2.0–2.5 mm *cf.* 5–7 mm long) with only 1–3 flowers (*cf.* up to 15 flowers), but as it is in bud with only a few flowers opened, the possibility that some peduncles produce more than three flowers in more mature inflorescences cannot be completely ruled out. Flower colour is recorded as pink, but that may be because the inflorescences are still in bud. *E. Wittwer* 813 also differs in having smaller leaves, commonly only three stamens per flower and larger petals (*c.* 1.7 mm long *cf.* 1.4–1.6 mm long). More material is needed to determine whether these differences are sufficiently reliable to warrant formal recognition of more than one entity.

Scholtzia oleosa Rye, *sp. nov.*

Typus: north of Northampton, Western Australia [precise locality withheld for conservation reasons], 23 September 2002, *M.E. Trudgen* MET 21676 (*holo*: PERTH 06361005; *iso*: CANB, K, MEL, NSW).

Scholtzia sp. Eurardy (J.S. Beard 6886), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 0.4–3 m high, 0.5–4 m wide; flowering branchlets with peduncles borne at 1–4 consecutive nodes, in umbel-like or other kinds of arrangements. *Leaves* widely antrorse or patent. *Petioles* 0.3–0.6 mm long. *Leaf blades* obovate to depressed obovate (usually broadly or very broadly obovate), 0.5–2.5 long, 1.2–1.7 mm wide, often 0.5–0.7 mm thick at first, entire; abaxial surface commonly raised and rounded over the full surface, but sometimes distinctly thinner on each side of the midvein, which is often grooved in the basal half but may be ridged close to the apex, with lateral veins obscure, the oil glands densely covering the surface rather than in rows. *Peduncles* 4–14.5 mm long, 0.5–0.8 mm wide, usually 3–14-flowered; secondary axes up to 1.5 mm long. *Basal bracts* 1.5–1.8 mm long. *Pedicels* 0.3–0.8 mm long. *Flowers* 4.5–5.5 mm diam. *Hypanthium* 1.1–1.3 mm long, rugose-pitted (the numerous pits each corresponding to a sunken gland). *Sepals* ovate to oblong or semicircular, commonly broadly ovate, (0.5–)0.8–1.3 mm long, thickened or ribbed and reddish at base; petaline margin 0.4–0.8 mm deep, entire. *Petals* 1.6–2.3 mm long, pale to medium pink. *Stamens* 7–10, with 0–3 opposite each sepal. *Longest filaments c.* 0.2 mm long. *Anthers* 0.35–0.4 mm long. *Ovary* inferior, 2- or 3-locular; ovules 1 per loculus. *Style* 0.6–0.8 mm long; stigma capitate. *Fruits* 1/2–2/3 inferior, 1.5–1.6 mm long, 1.5–1.6 mm wide; sepals erect; petals deciduous or persistent. *Seeds* 1.0–1.4 mm long, *c.* 0.55 mm wide.

Diagnostic features. Among species that have 1 ovule per loculus, *S. oleosa* is distinguished by the following combination of characters: leaves densely glandular; hypanthium pitted, ± as wide as long; stigma capitate.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Oct. 1973, *J.S. Beard* 6886 (PERTH, AD, CANB); 3 Dec. 2004, *A. Crawford* ADC 809 (PERTH); 13 Sep. 2001, *R. Davis* 10044 (PERTH): 2 Oct. 1998, *N. Gibson* 4143 (PERTH); 26 Oct. 2006, *S. Robinson* SR 29 (PERTH); 25 Sep. 2002, *M.E. Trudgen* MET 21713 (PERTH); 29 Aug. 2003, *Wildflower Society of WA EURA* 39 (AD, BRI, PERTH); 3 Oct. 2003, *Wildflower Society of WA EURA* 38 (PERTH).

Distribution and habitat. Extends from Coburn Station south to near Binnu (Figure 5B), in yellowish to reddish sandy soils.

Phenology. Flowers from August to October. Fruits recorded from October and December.

Etymology. From the Latin *oleum* (oil) and *-osus* (abounding in), referring to the numerous oil glands on the leaves and hypanthium.

Conservation status. Listed by Smith and Jones (2018) as Priority Two under the name *S.* sp. Eurardy (J.S. Beard 6886). This species has many more collections than when it was previously assessed for conservation status so should probably be reduced in priority.

Co-occurring species. *Scholtzia oleosa* (*M.E. Trudgen* MET 22151) has been recorded growing with a member of the *S. obovata* complex (*M.E. Trudgen* MET 22153), with both species adjacent to a patch of vegetation where *S. tenuissima* (*M.E. Trudgen* MET 22154) occurred.

Affinities. This species belongs to the *S. capitata* complex, in which there are crowded oil glands on the leaves and also on the hypanthium, where the glands are sunken into pits. *Scholtzia oleosa* differs from *S. capitata* in its less elongated hypanthium, usually shorter leaves, and usually shorter (4–14.5 mm *cf.* 8–18 mm) and fewer-flowered peduncles (3–14-flowered *cf.* usually 9–23-flowered). It also differs in having the ovary commonly 3-locular (*cf.* consistently 2-locular). As the two taxa overlap in range and flowering time, they may well have the opportunity to hybridise, which could account for one or two specimens that are difficult to identify.

Notes. Specimens from north of Eurardy (e.g. *F. Lullfitz* L 3197) have a consistently 2-locular ovary and tend to have small sepals whereas most specimens from Eurardy southwards have a 3-locular ovary.

Scholtzia peltigera Rye, *sp. nov.*

Typus: Eurardy Station, Western Australia [precise locality withheld for conservation reasons], 1 November 2016, *B. Parkhurst* BP 1 (*holo*: PERTH 08986533; *iso*: CANB, K, MEL, NSW).

Scholtzia sp. Bungabandi (M. Quicke EURA 48), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub 0.5–2.0 m high, width not recorded, single-stemmed at base; flowering branchlets with peduncles borne at 1–5 consecutive nodes, sometimes with their flowers combined into a dense cluster. *Leaves*

widely antrorse to patent, sessile, with a broad, stem-clasping base. *Leaves* broadly to depressed ovate in outline, 1.3–1.8 mm long, 1.5–2.5 mm wide, 0.5–1.1 mm thick, with a clear-translucent margin up to 0.15 mm deep or rarely slightly deeper, entire; abaxial surface raised throughout, rounded, with lateral veins obscure, the oil glands in 3 or more rows on each side of midvein, usually with 3–5 large glands in innermost rows. *Peduncles* 2–8 mm long, 0.3–0.5 mm wide, mostly 3–12-flowered; secondary axes up to 0.4 mm long. *Basal bracts* caducous or deciduous, 1.2–1.5 mm long. *Pedicels* 0.2–0.7 mm long. *Flowers* 4.0–5.5 mm diam. *Hypanthium* 0.8–1.3 mm long, with prominent glands, becoming smooth in fruit. *Sepals* entire; outer ones almost triangular to depressed ovate, short, slightly ridged at base, with a scarious margin; inner ones mostly broadly ovate, 1.0–1.3 mm long, largely or fully scarious but with base tending to be glandular and reddish. *Petals* 1.7–2.0 mm long, white or pale pink. *Stamens* 7–10, with 1–3 opposite each sepal. *Longest filaments* 0.5–0.6 mm long. *Anthers* 0.25–0.3 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.5–0.7 mm long; stigma capitate. *Fruits c.* 1/2 inferior, 1.6–1.7 mm long, *c.* 1.4 mm wide; sepals spreading or recurved; petals persistent. *Seeds c.* 1.3 mm long, 0.5–0.6 mm wide.

Diagnostic features. Unique in having stem-clasping, sessile leaves. Other important characters: leaves broader than long; peduncles 2–8 mm long, mostly 3–12-flowered; ovary 2-locular, with 2 ovules per loculus.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 Nov. 2004, *M. Quicke* EURA 48 (BRI, NSW, PERTH); 8 Sep. 2016, *B.L. Rye, J. Norman & B. Parkhurst* BLR 290166 (PERTH); 23 Aug. 2015 *Wildflower Society of WA* CREEK NORTH 2/22 (PERTH).

Distribution and habitat. Known only from Eurardy Station (Figure 3B), mostly collected from a site on yellow sand, in a slight hollow well above a usually dry creek, in low open *Eucalyptus* woodland over *Acacia-Scholtzia* tall shrubs.

Phenology. Flowers recorded from September to November, and mature fruits in late November.

Etymology. From the Latin *pelta* (small, crescent-shaped shield) and *-ger* (bearing), referring to the presence of sessile, somewhat stem-clasping, leaves along the stems. Each leaf has three surfaces, the broad base that shallowly clasps the stem and is attached near its centre to the stem, the broadly crescent-shaped abaxial surface, and the smaller, incurved adaxial surface.

Vernacular name. Eurardy Scholtzia.

Conservation status. Priority One under Conservation Codes for Western Australian Flora. Listed with this priority by Smith and Jones (2018) under the name *S.* sp. Bungabandi (M. Quicke EURA 48), *S. peltigera* has a very restricted distribution.

Co-occurring species. There is one record (*B.L. Rye, J. Norman & B. Parkhurst* BLR 290166) of *S. peltigera* growing intermixed with *S. truncata* (*B.L. Rye, J. Norman & B. Parkhurst* BLR 290165), but only the latter was in flower.

Affinities. *Scholtzia peltigera* is readily distinguished from all other members of the genus by its sessile, stem-clasping leaves, and it is not clear from its morphology which of the other species is likely to be its closest relative.

Notes. Although narrow translucent margins are found on the leaves of a number of *Scholtzia* species, they tend to be more noticeable in *S. peltigera*, perhaps due to the contrast with the remainder of its very short, thick leaves.

Scholtzia pentamera Rye, *sp. nov.*

Typus: 7 km N along Yerina Springs Road from Port Gregory Road, Western Australia, 15 August 1996, *E. Holland & K. Kershaw* EH 1539 (*holo*: PERTH 04506111; *iso*: K, MEL, NSW).

Shrub 0.6–2.5(–3) m high, commonly 1–2.5 m wide; flowering branchlets mostly with peduncles borne at 8–23 consecutive nodes. *Leaves* widely antrorse to patent. *Petioles* 0.1–0.7 mm long. *Leaf blades* orbicular-cordate, 2.5–5 mm long, 3–6 mm wide, with a translucent margin less than 0.1 mm deep, entire; abaxial surface level except for a narrow raised midvein, usually with 4–6 lateral veins clearly visible on each side of midvein, the oil glands in 4 or more rows on each side of midvein, mostly with 5–7 glands in innermost rows. *Peduncles* 4–13 mm long, 0.4–0.6 mm wide, mostly 3–15-flowered; secondary axes up to 1.5 mm long. *Bracts* 1.3–3 mm long, deciduous. *Pedicels* 0–1.2 mm long. *Flowers* 3.5–5.0 mm diam. *Hypanthium* 1.5–2.0 mm long, wrinkled-ribbed or fairly smooth. *Sepals* usually broadly ovate to depressed elliptic, 0.5–0.9 mm long, almost fully scarious but outer ones often narrowly ridged or with a somewhat ridged green base; petaline margin 0.5–0.8 mm deep, entire. *Petals* 1.3–2 mm long, white or pink, deciduous in fruit. *Stamens* 5, with 1 opposite each sepal. *Longest filaments* 0.25–0.4 mm long. *Anthers* 0.25–0.35 mm long. *Ovary* inferior, 1- or 2-locular; ovules 2 per loculus. *Style* 0.3–0.4 mm long; stigma capitate. *Fruits* inferior, 1.5–1.8 mm long, *c.* 0.8 mm wide; sepals erect; petals deciduous. *Seeds c.* 1.2 mm long, *c.* 0.65 mm wide.

Diagnostic features. Differs from *S. bellairsiorum* and *S. uberiflora* in having smaller flowers, including a shorter style, and only five stamens.

Distribution and habitat. Extends from Ajana south to and near Greenough (Figure 5A).

Phenology. Flowers from July to November.

Etymology. From the Greek *penta-* (five-) and *-merus* (refers to parts or their numbers) as the constant stamen number of five per flower in this species matches the number of sepals and petals.

Vernacular name. Constant Scholtzia. This is the only species of *Scholtzia* known to have a constant stamen number, rather than having the number vary between flowers.

Affinities. Very similar to *S. uberiflora* overall, for example in having leaves often with multiple spreading veins visible, and both taxa are unusual in having long peduncles borne at many consecutive nodes along the stems, as other species with long peduncles (sometimes exceeding 10 mm) have them at a maximum of 6 nodes and mostly at 1–4 nodes. *Scholtzia uberiflora* differs in having smaller bracts but usually larger flowers, 6–10 stamens per flower, with 1–3 opposite each sepal, a style 0.45–0.8 mm long, and in always having a 2-locular ovary.

Notes. Two allopatric subspecies are recognised; these could be treated as separate species but are certainly more similar to one another than either is to *S. uberiflora*.

a. Scholtzia pentamera subsp. **collina** Rye, *subsp. nov.*

Typus: Howatharra, Western Australia [precise locality withheld for conservation reasons], 13 September 1977, *A.S. George* 14878 (*holo*: PERTH 04062647; *iso*: CANB, K).

Bracts 2–3 mm long. *Ovary* markedly expanded distally, 2-locular.

Diagnostic features. Distinguished from the other subspecies by its longer bracts and 2-locular ovary.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 July 1966, *A.C. Burns* 8 (PERTH); 3 July 1966, *A.C. Burns* 9 (PERTH); 26 Aug. 1983, *R.J. Cranfield* 2971 (PERTH).

Distribution and habitat. Occurs in Moresby Range (Figure 5A), the habitat recorded as 'gravelly soil' or 'lateritic soil'.

Etymology. From the Latin *collinus* (pertaining to low hills), as this subspecies is restricted to a range of hills.

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (M. Smith, pers. comm.). Probably restricted to a small area within a nature reserve.

Notes. Subsp. *collina* is like the related species *S. uberiflora* in its ovary shape and loculus number, but is otherwise much more like *S. pentamera* subsp. *pentamera*. All three taxa differ in bract size.

b. Scholtzia pentamera Rye subsp. **pentamera**

Scholtzia sp. Northampton (A. Strid 20714), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Bracts 1.3–1.8 mm long. *Ovary* tubular, 1-locular.

Selected specimens examined. WESTERN AUSTRALIA: S of Ogilvie, 3 Sep. 1947, *N.T. Burbidge* 2158 (PERTH); Bishops Gully Rd, 4.3 km from Port Gregory Rd, 8 July 1997, *R. Davis* 3624 (PERTH); private property, Rob Rd, slope above Yarda Gully Creek, W of homestead, 30 May 2008, *A. Gunness* AG 3022 (PERTH); W side of Ogilvie Rd W, close to Hutt River crossing, W of Binnu, 25 July 2008, *M. Hislop* 3783 (PERTH); 7 km N along Yerina Springs Rd from Port Gregory Rd, 15 Aug. 1996, *E. Holland* 1539 *& K. Kershaw* (MEL, NSW, PERTH); North West Coastal Hwy, 8 km S of junction with Ogilvie East Rd and 9.5 km S of crossing of the Hutt River, 11 Sep. 1999, *J.W. Horn* 2400 (AD, PERTH); on dunes near Flat Rocks, SE of Greenough, 4 Oct. 1972, *S. Paust* 1222 (PERTH); 9.5 km N of Northampton along North West Coastal Hwy, 7 Oct. 1982, *A. Strid* 20714 (PERTH).

Diagnostic features. Distinguished from the other subspecies in having a 1-locular, tubular ovary.

Distribution and habitat. Mostly collected between Ajana and Northampton, but with one outlying specimen from Flat Rocks Beach, near Greenough (Figure 5A), in varied habitats including yellow sand, the outlier recorded from sand dunes.

Conservation status. Not listed by Smith and Jones (2018) but does not appear to be known from any nature reserves so may need to be surveyed.

Notes. The uni-locular ovary is a rarity in *Scholtzia*, otherwise being known only in *S. uniovulata*, *Scholtzia pentamera* subsp. *pentamera* is unique in having a tubular ovary.

Scholtzia prostrata Rye, *sp. nov.*

Typus: Burma Rd, Western Australia [precise locality withheld for conservation reasons], 13 October 1969, *A.C. Burns* 138 (*holo*: PERTH 06165192; *iso*: CANB, MEL).

Scholtzia sp. Burma Road (A.C. Burns 138), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Prostrate *shrub c.* 0.1 m high, commonly 0.3–1.0 m wide, at least sometimes with multiple, close branches arising at ground level from a woody base; flowering branchlets with peduncles borne at up to 35 consecutive nodes, usually in a one-sided raceme-like arrangement. *Leaves* antrorse to patent. *Petioles* 0.3–0.5 mm long. *Leaf blades* narrowly obovate to elliptic, 2.5–4.5 mm long, 0.8–2 mm wide, with a midrib commonly 0.3–0.5 mm thick but remainder thin, ciliolate or ciliate-laciniate, the longest cilia 0.2–0.3 mm long; abaxial surface raised along central part, often with a groove along midvein, with lateral veins obscure, the oil glands inconspicuous or in usually 2 or 3 main rows on each side of midvein, with 3–6 glands in main rows. *Peduncles* 1.5–3 mm long, 0.25–0.4 mm wide, 1-flowered. *Bracteoles* 1.1–1.5 mm long, deciduous or persistent. *Pedicels* 0.2–0.7 mm long. *Flowers* 5–8 mm diam. *Hypanthium* 0.8–1.0 mm long, finely rugose. *Sepals* broadly ovate to almost semicircular, usually very broadly ovate, 0.7–1.2 mm long, the herbaceous base ridged; petaline margin 0.6–0.8 mm deep, denticulate-ciliolate or dentate. *Petals* 2.5–3.5 mm long, white or pale pink. *Stamens* 11–17, in a continuous circle. *Longest filaments* 1.5–2.0 mm long. *Anthers* 0.3–0.35 mm long. *Ovary c.* 1/2 inferior, 2-locular; ovules 2 per loculus. *Style* 1.5–2.3 mm long; stigma capitate. *Fruits c.* 1/2 inferior, probably 1.5–1.8 mm long, not seen at maturity; sepals erect; petals persistent.

Diagnostic features. Among the species that have 2 ovules per loculus and mostly to consistently 1-flowered peduncles, *S. prostrata* is distinguished by the following combination of characters: peduncles 1.5–3 mm long; hypanthium not ribbed; sepals ridged at base; stamens 11–17, in a continuous circle; style 1.5–2.3 mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Oct. 1963, *A.C. Burns 3* (NSW, PERTH); 3 Oct. 2007, *A. Crawford* ADC 1392 (PERTH); 23 Oct. 1998, *G.J. Keighery & N. Gibson* 3011 (PERTH); 22 Mar. 2001, *S.J. Patrick* 3780 *& A. Chant* (PERTH); 24 Oct. 2001, *S.J. Patrick* 4077 (PERTH).

Distribution and habitat. Occurs between Ambania and Strawberry, east of Walkaway (Figure 2A), in sand, often over laterite, in heath, often with emergent banksias or mallees.

Phenology. Flowers from October to December.

Conservation status. Recently listed as Priority Three under Conservation Codes for Western Australian Flora. The species is known from at least one nature reserve.

Etymology. From the Latin *prostratus* (prostrate, lying flat along the ground), in reference to the habit of this species. Several apparently closely related species also tend to be prostrate but the habit is possibly most extreme in *S. prostrata*, with the species reported to be largely hidden (*S. Patrick* 4097) by other heath species.

Vernacular name. Creeping Scholtzia.

Co-occurring species. A possible hybrid (*S. Patrick* 4079 PERTH 08989702) was collected together with *S. prostrata* (*S. Patrick* 4079, PERTH 05947561). The putative hybrid is similar to *S. prostrata* but shows two significant differences, as it has up to three flowers per peduncle and fewer stamens arranged in antisepalous groups. These differences would be consistent with the other parent species being either *S. ciliata* or *S. obovata*, both of which are common in the general area and may well co-occur with *S. prostrata*.

Affinities. This is the northernmost member of the *S. chapmanii* complex and has the fewest stamens on average. *Scholtzia prostrata* is most similar to *S. chapmanii* but differs in that its usually shorter hypanthium lacks the antisepalous ribs that are usually obvious in *S. chapmanii*. Also, its leaves tend to be broader and more spreading, and its sepals tend to be less prominently ridged at the base.

Notes. Possibly this taxon should be treated as a subspecies of *S. chapmanii*, but since there are multiple minor differences between them it seems better to treat them as distinct species. The two taxa appear to be geographically separated by a distance of at least 50 km.

As in *S. chapmanii*, there is just one specimen of *S. prostrata* showing that the base of the plant may have multiple stems arising from it at about ground level. In this case, two plants mounted on *A.C. Burns* 138, are complete except for their roots. There are no specimens with mature fertile fruits.

Scholtzia quindecim Rye, *sp. nov.*

Typus: north of Watheroo, Western Australia [precise locality withheld for conservation reasons], 5 October 1984, *J.D. Briggs* 1721 (*holo*: PERTH 03628191; *iso*: AD, CANB).

Scholtzia sp. Gunyidi (J.D. Briggs 1721), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Prostrate *shrub* usually 0.05–0.15 m high, 0.6–2.5 m wide; flowering branchlets mostly with peduncles borne at 4–17 consecutive nodes, usually in a one-sided raceme-like arrangement. *Leaves* antrorse to patent. *Petioles* 0.3–0.5 mm long. *Leaf blades* narrowly obovate to narrowly oblong, 3.5–5 mm long, 0.5–1.1 mm wide, up to 0.5 mm thick, entire or denticulate-ciliolate; abaxial surface raised along the midvein, the raised part rounded, with lateral veins obscure, the oil glands usually in 2 rows on each side of midvein, with 4–8 glands in innermost rows but not obvious. *Peduncles* 3–7 mm long, 0.25–0.5 mm wide, nearly always 1-flowered. *Bracteoles* 1.1–2.2 mm long, deciduous or persistent. *Pedicels* 0.4–0.8 mm long. *Flowers* 6–8 mm diam. *Hypanthium* 0.9–1.1 mm long, finely rugose. *Sepals* broadly ovate to almost semicircular, usually very broadly ovate, 1.1–1.9 mm long, the herbaceous base thickened or ridged; petaline margin 0.7–1.2 mm deep, entire. *Petals* 3–4 mm long, white or pale pink. *Stamens* 13–18, in a continuous circle. *Longest filaments* usually 2–2.5 mm long. *Anthers*

0.4–0.5 mm long. *Ovary c.* 1/2 inferior, 2-locular; ovules 2 per loculus. *Style* 2.5–3.4 mm long; stigma ± capitate. *Fruits c.* 1/2 inferior, only sterile ones seen; sepals erect; petals probably persistent.

Diagnostic features. Among the species with two ovules per loculus and mostly to consistently 1-flowered peduncles, *S. quindecim* is distinguished by having peduncles 3–7 mm long, an unribbed hypanthium and a style 2.5–3.4 mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 27 Oct. 1992, *E.A. Griffin* 7716 (PERTH); Reserve 21788, 20 Nov. 1992, *S.J. Patrick* 1450 (PERTH); 9 Nov. 1961, *Mrs Strickland s.n.* (PERTH).

Distribution and habitat. Occurs from Gunyidi to Dalwallinu (Figure 2A), in yellow or grey sand, recorded in sites with low woodlands or mallees.

Phenology. Flowers from September to November.

Etymology. From the Latin *quindecim* (fifteen), referring to the number of stamens, since this species has an average of about 15 stamens per flower.

Vernacular name. Gunyidi Scholtzia.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Listed with this priority by Smith and Jones (2018) under the name *S.* sp. Gunyidi (J.D. Briggs 1721).

Affinities. This is the most inland member of the *S. chapmanii* complex and the only one with more or less entire leaves. It has the longest peduncles within the complex. It may also have longer styles than the other species, as measurements of 2.8 and 3.4 mm have been recorded for styles on the single fruiting specimen. No other reliable measurements of mature styles could be made, but specimens in the early stages of flowering have shorter styles to *c.* 2.5 mm long.

Notes. A single 2-flowered peduncle has been observed, indicating that the peduncles are not always 1-flowered. Material with mature fertile fruits is needed.

Scholtzia recurva Rye, *sp. nov.*

Typus: south of Overlander Roadhouse, Western Australia [precise locality withheld for conservation reasons], 26 September 2002, *M.E. Trudgen* 21720 (*holo*: PERTH 08986525; *iso*: CANB, K, MEL).

Scholtzia sp. Overlander (M.E. Trudgen 12138), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 20 July 2018].

Shrub 1–2 m high, 1.5–3.0 m wide, rather spindly; flowering branchlets commonly with peduncles borne at 1–4 consecutive nodes in a raceme-like arrangement. *Leaves* antrorse. *Petioles* 0.1–0.35 mm long. *Leaf blades* broadly obovate, 1.3–1.7 mm long, 1.1–1.5 mm wide, with a clear-translucent margin less than 0.1 mm deep, denticulate/ciliolate, the apex recurved and with a point up to 0.15 mm long; abaxial surface gradually raised towards centre, sometimes grooved along midvein, with lateral veins obscure, the oil glands in 1 or 2 main rows on each side of midvein, with 3–5 glands in innermost rows.

Peduncles 4–6.5 mm long, 0.3–0.35 mm wide, mostly 6–9-flowered; secondary axes up to 1.3 mm long. *Bracts* 1.3–1.5 mm long, deciduous. *Pedicels* 0–0.5 mm long. *Flowers c.* 4 mm diam. *Hypanthium* 1.5–2 mm long, dotted with oil glands but otherwise rather smooth. *Sepals* ± deltate to very broadly ovate, 0.35–0.45 mm long, the outer ones with a green ridge; petaline margin *c.* 0.15 mm deep, entire. *Petals* 1.5–1.7 mm long, white or pale pink. *Stamens* commonly 10, with 1–3 opposite each sepal. *Longest filaments c.* 0.35 mm long. *Anthers c.* 0.3 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style c.* 0.5 mm long; stigma capitate. *Fruits c.* 3/4 inferior, sterile ones 1.6–1.75 mm long, 1.3–1.4 mm wide; sepals erect or incurved; petal persistence unknown. *Seeds* probably *c.* 1.2 mm long.

Diagnostic features. Among the species that have a 2-locular ovary with 2 ovules per loculus, *S. recurva* is distinguished by the following combination of characters: petioles mostly 0.1–0.3 mm long; leaf blades 1.3–1.7 mm long, longer than wide, with apex recurved and shortly pointed; peduncles 4–6.5 mm long, mostly 6–9-flowered; hypanthium smooth apart from its glands.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 Oct. 1994, *M.E. Trudgen* 12138 (NSW, PERTH); 26 Sep. 2002, *M.E. Trudgen* 21721 (PERTH).

Distribution and habitat. Occurs in the Meadow Station area (Figure 6A), in red or orange-brown soil on the slopes of dunes or in the swale, with *Acacia* high open shrubland.

Phenology. Flowers recorded in late October. A few old fruits were present on the specimens collected in late September.

Etymology. From the Latin *recurvus* (curved backwards), referring to the recurved apex of the leaves, which is of importance in distinguishing this species.

Conservation status. Recently listed as Priority One under Conservation Codes for Western Australian Flora. Known from three collections that were possibly all made from a single population.

Affinities. Closest in morphology to *S. thinicola* Rye but differing in having leaves with a recurved and shortly pointed apex. *Scholtzia recurva* also has shorter sepals with a narrower petaline margin, and tends to have longer peduncles but shorter pedicels. The two species occupy a similar habitat but with *S. recurva* occurring more than 100 km north of the range of *S. thinicola*.

Notes. *Scholtzia recurva* appears to have the smallest leaves of all the species with two ovules per loculus. The description of its flowers is based entirely on one specimen. Further collections of both flowering and fruiting material are needed. All fruits dissected were sterile, although one had a cavity that appeared to have contained an incompletely formed seed *c.* 1.2 mm long.

Scholtzia subsessilis Rye, *sp. nov.*

Typus: South-west of Morawa, Western Australia [precise locality withheld for conservation reasons], 15 September 1985, *B.J. Conn* 2159 (*holo*: PERTH 03414515; *iso*: B, CHR, MEL, MO, NSW all *n.v.).*

Scholtzia sp. Billeranga Hills (B.J. Conn 2159), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

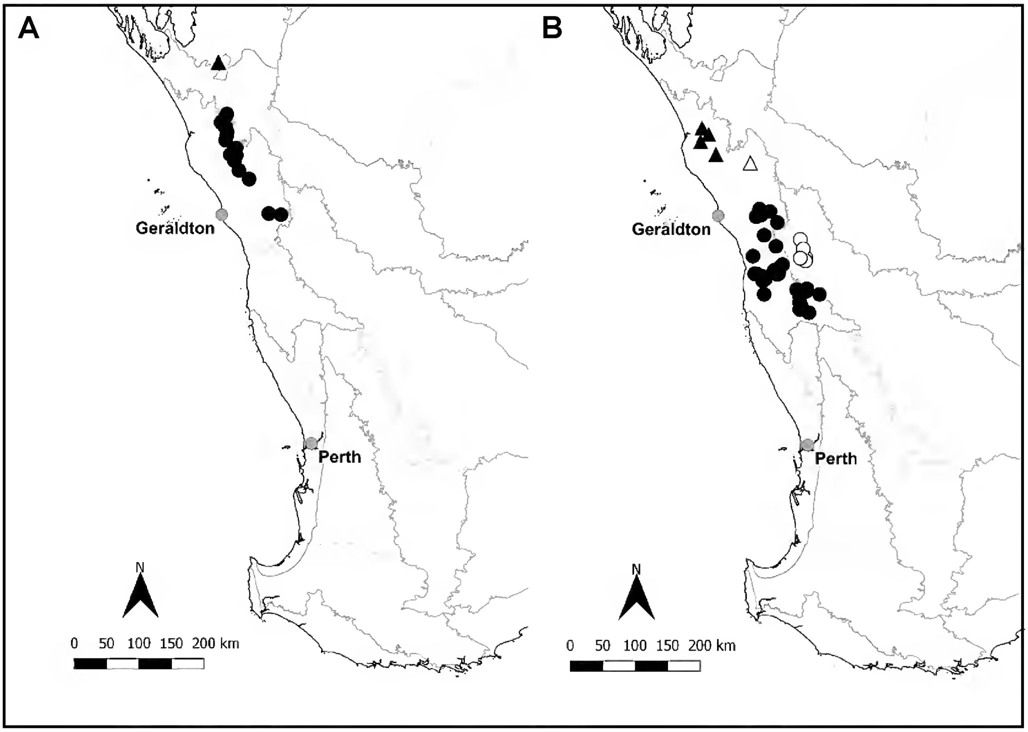

Figure 6. Distribution of *Scholtzia* species. A – *S. recurva* (▲) and *S. truncata* (●); B – *S. subsessilis* (○), *S. tenuissima* (▲), *S. trilocularis* (●) and *S.* sp. Whelarra (△).

Shrub 0.8–2.5 m high, erect, with one record of 1.5 m wide; flowering branchlets with peduncles borne at 1–5 consecutive nodes, often with the flowers combined into a dense cluster. *Leaves* antrorse or widely antrorse. *Petioles* absent or not exceeding 0.25 mm long. *Leaf blades* mostly broadly elliptic or broadly obovate, 1.5–2.3 mm long, 1.7–2.2 mm wide; abaxial surface often raised and grooved in basal 1/2–2/3 and ridged along midvein above, or ridged for full length, with lateral veins obscure, the oil glands in 2 or 3 main rows on each side of midvein, with 3–5 glands in innermost rows. *Peduncles* 2.5–5.5 mm long, 0.4–0.6 mm wide, 3–6-flowered; secondary axes absent or up to 0.3 mm long. *Bracts* 0.8–1.4 mm long, caducous or deciduous. *Pedicels* 0.2–0.8 mm long. *Flowers* 5–6 mm diam. *Hypanthium* 1.1–1.5 mm long, rugose-pitted. *Sepals* broadly to depressed ovate, 0.5–0.6 mm long, the outer sepals ridged and dark reddish at base; petaline margin *c.* 0.3 mm deep, entire. *Petals* 2.3–2.6 mm long, white or pink. *Stamens* usually 8–10, with 1–3 opposite each sepal. *Longest filaments* 0.7–0.8 mm long. *Anthers c.* 0.3 mm long. *Ovary* inferior, 3-locular; ovules 1 per loculus. *Style* 1–1.2 mm long; stigma tending to be peltate. *Fruits* largely inferior, not seen at maturity; sepals incurved; petals deciduous.

Diagnostic features. Among species that have a 3-locular ovary with 1 ovule per loculus, *S. subsessilis* is distinguished by having sessile or subsessile leaves. Other important characters: peduncles 2.5–5.5 mm long, 3–6-flowered; hypanthium pitted-rugose; stamens usually 8–10, with 1–3 opposite each sepal.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Sep. 1996, *A. Carr* 368 (PERTH); 25 Sep. 1990, *R.J. Cranfield* 7847 & *P.J. Spencer* (CANB, PERTH); 19 Aug. 1997, *F. Keast* M6A 067 (PERTH).

Distribution and habitat. Occurs in the Billeranga Hills area, west of Morawa (Figure 6B), in sandy soils.

Phenology. Flowers from August to December. Fruits recorded from September to December.

Etymology. From the Latin *sub-* (somewhat, less than) and *sessilis* (sessile, unstalked), as the leaves are almost sessile.

Vernacular name. Billeranga Scholtzia.

Conservation status. Recently listed as Priority One under Conservation Codes for Western Australian Flora. *Scholtzia subsessilis* does not appear to have been collected from any nature reserves.

Affinities. The affinities of *S. subsessilis* are unclear, but it shows some similarities to *S. halophila*, which has longer petioles and peduncles.

Notes. Good fruiting material is needed for this species.

Scholtzia tenuissima Rye, *sp. nov.*

Typus: Kalbarri National Park, Western Australia [precise locality withheld for conservation reasons], 30 November 2003, *M.E. Trudgen* MET 22155 (*holo*: PERTH 08238162; *iso*: CANB, K, MEL).

Scholtzia sp. Z-Bend (Bellairs-Kalflora 912a), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub spindly, 0.4–1.0 m high, 0.3–1.0 m wide; flowering branchlets with peduncles borne at 1–4 (–7) consecutive nodes, in a very open raceme-like arrangement or with flowers more clustered. *Leaves* appressed or antrorse. *Petioles* 0.1–0.3 mm long. *Leaf blades* narrowly obovate or obovate, 1.4–2.7 mm long, 0.6–1 mm wide, 0.3–0.5 mm thick; abaxial surface highly raised throughout, rounded or flattened, with lateral veins obscure, the oil glands in 2 or 3 main rows on each side of midvein, with 4–6 glands in innermost rows. *Peduncles* 5.5–13 mm long, 0.15–0.25 mm wide, 1–3-flowered; secondary axes up to 2.5 mm long. *Bracts* 0.8–1.3 mm long, deciduous. *Pedicels* 0–0.5 mm long. *Flowers* 4–5.5 mm diam. *Hypanthium* 1.2–1.4 mm long, rugose. *Sepals* mostly ± broadly ovate, 1.0–1.4 mm long, scarious throughout, not ridged, tending to be recurved, entire. *Petals* 1.5–2.5 mm long, white. *Stamens* 12 or 13, with 1–3 opposite each sepal. *Longest filaments* 0.8–1.2 mm long. *Anthers c.* 0.35 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.8–1.0 mm long; stigma capitate. *Fruits c.* 1/2 inferior, 1.8–2.2 mm long, 1.3–1.4 mm wide; sepals reflexed; petals persistent. *Seeds* 1.3–1.4 mm long, 0.6–0.7 mm wide.

Diagnostic features. Among the species that have a 2-locular ovary with 2 ovules per loculus, *S. tenuissima* is distinguished by the following combination of characters: petioles 0.1–0.3 mm long; peduncles extremely slender (0.15–0.25 mm wide), 1–3-flowered, 5.5–13.0 mm long, with secondary axes up to 2.5 mm long; hypanthium rugose; sepals entirely scarious, reflexed in fruit.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 17 Nov. 1986, *Bellairs-Kalflora* 912A (PERTH); 6 Nov. 1995, *D. & B. Bellairs* 3008 (PERTH); 16 Sep. 1999, *D. & B. Bellairs* 6041 (PERTH).

Distribution and habitat. Occurs in Kalbarri National Park (Figure 6B), in sandy soil, sometimes over sandstone or laterite, one record from a winter-wet flat, where *S. tenuissima* formed a low shrubland over *Lepidobolus* open sedgeland.

Phenology. Flowers from September to December. Mature fruits recorded in November

Etymology. From the Latin *tenuis* (thin) and *-issimus* (very), i.e. the thinnest or most delicate, in reference to the peduncles, which are long (up to 13 mm) but extremely slender (0.15–0.25 mm wide).

Vernacular name. Delicate Scholtzia.

Conservation status Priority Two under Conservation Codes for Western Australian Flora. Listed with this priority Smith and Jones (2018) under the name *S.* sp. Z-Bend (Bellairs-Kalflora 912a). Known from an area *c.* 30 km long within a large national park.

Co-occurring species. *Scholtzia tenuissima* (*M.E. Trudgen* MET 22154) has been recorded adjacent to, and downhill from, an area where *S. oleosa* (*M.E. Trudgen* MET 22151) and a member of the *S. obovata* complex (*M.E. Trudgen* MET 22153) co-occurred.

Affinities. Very similar to *S.* sp. Whelarra (M.E. Trudgen 12018), both taxa having a somewhat spindly appearance and very slender peduncles. *Scholtzia* sp. Whelarra is very poorly known but occurs to the south-east (Figure 6B) and has broader, smoother, less thickened leaves, somewhat wider peduncles, much shorter secondary axes, and possibly fewer stamens. Good flowering material is needed to determine stamen numbers and other flowering characters for *S.* sp. Whelarra, but the differences in its leaves indicate that it should probably be treated as a distinct species rather than as a subspecies of *S. tenuissima*.

Notes. The sepals are about 2/3 the length of the petals. Only *S. denticulata* sometimes has a greater sepal/petal length ratio.

Scholtzia thinicola Rye, *sp. nov.*

Typus: Binnu East Road, Western Australia [precise locality withheld for conservation reasons], 5 December 1993, *M.E. & M.R. Trudgen* MET 12013 (*holo*: PERTH 03979318; *iso*: AD, BRI, CANB, K, NSW, MEL).

Scholtzia sp. Binnu East Road (M.E. Trudgen 12013), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 401 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Valentine Road (S. Patrick 2142), G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub commonly 1.0–1.5 m high, with one record of 2 m wide; flowering branchlets with peduncles borne at 1–3 consecutive nodes with the flowers combined into a dense cluster. *Leaves* mostly widely antrorse. *Petioles* 0.1–0.3 mm long. *Leaf blades* obovate to almost circular in outline, 1.4–3.7 mm long, 1.0–1.6 mm wide, 0.35–0.6 mm thick, sometimes with a minute subterminal point at first, entire; abaxial surface somewhat angled, with the central part flattened and with sloping sides, with lateral veins obscure, the oil glands usually in 2 or 3 main rows on each side of midvein but inconspicuous. *Peduncles* 0.7–4 mm long, 0.5–0.7 mm wide, mostly 3–9-flowered; secondary axes scarcely developed or up to 0.6 long. *Bracts* 0.7–1.4 mm long, deciduous or persistent. *Pedicels* 0.3–2.0 mm long. *Flowers c.* 4 mm diam. *Hypanthium* 0.8–1.2 mm long, rugose. *Sepals* transversely oblong to depressed ovate, mostly broadly ovate, 0.7–1.2 mm long, the herbaceous base ridged; petaline margin 0.4–0.6 mm deep, entire. *Petals* 1.5–2.3 mm long, white or pale pink. *Stamens* 10–12, with 1–3 opposite each sepal. *Longest filaments* 0.25–0.4 mm long. *Anthers* 0.4–0.5 mm long. *Ovary* inferior, 2-locular; ovules 2 per loculus. *Style* 0.5–0.8 mm long; stigma capitate. *Fruits* 1/2–2/3 inferior, 1.3–2.0 mm long, 1.3–1.5 mm wide; sepals erect; petals persistent for some time. *Seeds* 0.9–1.6 mm long, 0.6–0.8 mm wide.

Diagnostic features. Among the species that have a 2-locular ovary with 2 ovules per loculus, *S. thinicola* is distinguished by the following combination of characters: petioles 0.1–0.3 mm long; leaf blades 1.4–3.7 mm long, longer than wide, with apex straight and not pointed; peduncles 0.7–4.0 mm long, mostly 3–9-flowered; hypanthium rugose.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 21 Dec. 2005, *A.D. Crawford* 841 (PERTH); 12 Jan. 2005, *A.D. Crawford* 871 (K, PERTH); 29 Oct. 1991, *G.J. Keighery* 14734 (PERTH); 1 Nov. 1994, *S.J. Patrick* 2142 (PERTH); 12 Dec. 2002, *S.J. Patrick & G. Paczkowska* SP 4676 (PERTH).

Distribution and habitat. Occurs from near Yandi Station south to east of Mullewa (Figure 5A), on yellow sand dunes, with several records from the crest of the dunes.

Phenology. Flowers from October to December, with mature fruits recorded from November to January.

Etymology. From the Latin *thinium* (dune) and *-cola* (dweller) since the species is known only from sand dunes.

Vernacular name. Dune Scholtzia.

Conservation status. Priority One under Conservation Codes for Western Australian Flora. Listed with this priority by Smith and Jones (2018), under the names *S.* sp. Binnu East Road (M.E. Trudgen 12013) and *Scholtzia* sp. Valentine Road (S.J. Patrick 2142). This taxon is currently known from five locations, two of which are very close and probably represent a single population.

Co-occurring species. The type specimen (*M.E. & M.R. Trudgen* MET 12013) was collected from a site where it co-occurred with *S. uniflora* (*M.E. & M.R. Trudgen* MET 12011).

Affinities. Very similar to *S. recurva* in morphology and habitat; see *affinities* section under that species for details.

Notes. Like the inflorescences, the infructescences are globular and dense, and located well below the apex of each branchlet. The name *S.* sp. Valentine Road (S.J. Patrick 2142) was applied to southern specimens that tend to have longer peduncles than the other specimens.

Scholtzia trilocularis Rye, *sp. nov.*

Typus: 20 km north of Eneabba on Brand Highway, Western Australia, 8 October 1990, *S. Maley* 8 (*holo*: PERTH 04279115; *iso*: AD, MEL, NSW).

Scholtzia sp. Eneabba (S. Maley 8), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub erect, 0.4–2(–3?) m high, 1–2.3 m wide; flowering branchlets with peduncles borne at 1–4 consecutive nodes, often in an umbel-like arrangement. *Leaves* antrorse or widely antrorse. *Petioles* 0.2–0.8 mm long. *Leaf blades* obovate to almost circular, 1.5–3.5 mm long, 1.1–2.1 mm wide, entire; abaxial surface usually raised and flattened at centre in basal 1/2–3/4 and distally ridged along midvein or sometimes ridged along full length, with lateral veins obscure, the oil glands in 1–3 main rows on each side of midvein but inconspicuous. *Peduncles* 4–15 mm long, 0.4–0.6 mm wide, mostly 3–13-flowered; secondary axes up to 1.3 mm long. *Bracts* 0.9–1.8 mm long, deciduous. *Pedicels* mostly 0.6–1.0 mm long. *Flowers* 3.5–7 mm diam. *Hypanthium* 1.0–1.4 mm long, wrinkled-rugose or sometimes reticulate-rugose. *Sepals* usually broadly to depressed ovate, 0.5–1.0 mm long, the outer ones slightly to markedly ridged at base; petaline margin 0.3–0.6 mm deep, entire. *Petals* 1.5–2.5 mm long, pale or medium pink. *Stamens* 8–12, with 1–3 opposite each sepal. *Longest filaments* 0.4–0.7 mm long. *Anthers c.* 0.35 mm long. *Ovary* inferior, 3-locular; ovules 2 per loculus. *Style* 0.7–1.0 mm long; stigma capitate. *Fruits c.* 2/3 inferior, 1.6–1.8 mm long, *c.* 1.4 mm wide; sepals erect or spreading; petals persistent in early or mature fruit. *Seeds* 1.3–1.6 mm long, 0.6–0.7 mm wide.

Diagnostic features. Among species that have a 3-locular ovary with 2 ovules per loculus, *S. trilocularis* is distinguished by the following combination of characters: leaves entire; peduncles 4–15 mm long, mostly 3–13-flowered; stamens 8–12, with 1–3 opposite each sepal; petals 1.5–2.5 mm long.

Selected specimens examined. WESTERN AUSTRALIA: Loc. No. 144, Arrowsmith River Valley, near Blue Water Rd. Shallow siltstone (Mound Springs 16-19), E side, Arrino, 17 Oct. 2005, *J. Borger* CH 1710-1 (PERTH); Nebroo Nature Reserve, Bunney Rd, Western side Tag 21 ferricrete site, 17 Nov. 2009, *J. Borger* NR21 1 (PERTH); track between Ambania and Casuarina Rds,10 km S off Geraldton road, 13 Nov. 2005, *J. Docherty* 414 (PERTH); Moore Rd, 9 km S of Mullewa–Geraldton Rd, Indarra Nature Reserve, 23 Oct. 1998, *G.J. Keighery & N. Gibson* 5025 (BRI, CANB, PERTH); Mingenew, Oct. 1909, *J.H. Maiden s.n.* (PERTH); Brand Mudge Rd, 2.9 km N of Hughes Rd, W of Coorow, 22 Oct. 2001, *S.J. Patrick* 4051 (NSW, PERTH); on E boundary of park, Watheroo National Park, W of Watheroo, 7 Oct. 1971, *R.D. Royce* 9697 (PERTH).

Distribution and habitat. Extends from near Ambania (east of Geraldton) south to Watheroo National Park (Figure 6B), usually in sandy habitats, commonly in yellow sand, the dominant species often eucalypts (such as *E. todtiana*), *Allocasuarina campestris*, *Banksia* species or *Xylomelum angustifolium*.

Phenology. Flowers from August to November. Mature fruits recorded in November and December.

Conservation status. Not listed by Smith and Jones (2018); this species is known from a national park and from several nature reserves.

Etymology. From the Latin *tri-* (three) and *locularis* (having compartments or cells). Most of the species with two ovules per loculus have regularly 2-locular ovaries or have both 2- and 3-locular ovaries common, whereas this species is one of four that are regularly 3-locular.

Co-occurring species. Recorded (*M. Hislop* WF 3362) growing with two variants of *S. laxiflora* (*M. Hislop* WF 3363 & WF 3367) near Eneabba.

Affinities. Keys out with *S. spatulata*, which tends to have larger flowers with the sepals less ridged at the base. Another possible close relative is *S. oligandra* F.Muell. ex Benth., which differs in having denticulate to ciliate leaves and only 5–8 stamens.

Notes. In *S. trilocularis* all of the flowers examined had at least one stamen opposite each sepal, whereas in *S. spatulata* there may not be any stamens opposite one of the sepals of a flower.

Scholtzia truncata Rye, *sp. nov.*

Typus: Eurardy Station, Western Australia, 2 September 2004, *Wildflower Society of WA* EURA 171 (*holo*: PERTH 06922856; *iso*: K, MEL).

Scholtzia sp. Galena (W.E. Blackall 4728), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 402 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Scholtzia sp. Ajana East Road (M.E. Trudgen 21734 A), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 30 May 2016].

Shrub 0.5–3 m high, 0.6–3.5 m wide; flowering branchlets with peduncles borne at 1–5 consecutive nodes, often with their flowers combined into a terminal globular cluster. *Leaves* appressed to widely antrorse, but mostly antrorse. *Petioles* 0.3–0.5 mm long. *Leaf blades* broadly obovate to very broadly elliptic, 1.3–2.2 mm long, 1.4–2.0 mm wide, entire, with a very short mucro present on at least some of the leaves of each specimen; abaxial surface flattened at the centre for 1/2–2/3 of its length and ridged distally, with lateral veins obscure; oil glands in 1 or 2 main rows on each side of midvein, with 2–5 glands in innermost rows. *Peduncles* 0.5–2.0(–2.3) mm long, 0.4–0.6 mm wide, 1–3-flowered; secondary axes ± absent or up to 0.4 mm long. *Bracts* 0.6–1.8 mm long. *Pedicels* 0.3–1.0 mm long. *Flowers* 3.5–6.0 mm diam. *Hypanthium* 1.0–1.3 mm long, wrinkled or reticulate-rugose to pitted, sometimes becoming fairly smooth in mature fruit. *Sepals* broadly or very broadly ovate, 0.5–0.7 mm long, the base ribbed (but appearing scarious in fruit); petaline margin often hidden from side view, 0.3–0.5 mm deep, entire. *Petals* 1.5–2.5 mm long, white or pale pink. *Stamens* (5–)7–10(–12), with 0–3 opposite each sepal. *Longest filaments* 0.5–0.8 mm long. *Anthers* 0.25–0.3 mm long. *Ovary* inferior, 2- or 3-locular; ovules 1 per loculus. *Style* 0.9–1.6 mm long; stigma peltate. *Fruits c.* 1/2 inferior, 1.4–1.5 mm long, 1.8–1.9 mm wide; sepals strongly incurved; petals deciduous. *Seeds* 0.9–1.3 mm long, 0.6–0.8 mm wide.

Diagnostic features. Among species that have 1 ovule per loculus, *S. truncata* is distinguished by the following combination of characters: petioles 0.3–0.5 mm long; peduncles 0.5–2.0(–2.3) mm long, 1–3-flowered; sepals strongly incurved; petals 1.5–2.5 mm long; stamens usually 7–11; style 0.9–1.6 mm long, stigma peltate.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Sep. 1990, *A.H. Burbidge* 4349 (PERTH); 26 Aug. 1991, *A.H. Burbidge* 4365 (PERTH); 6 Aug. 1976, *R.J. Hnatiuk* 760431 (PERTH); 8 Sep. 2016, *B.L. Rye* 290165, *J. Norman & B. Parkhurst* (PERTH); 29 Aug. 1985, *C.I. Stacey* 768 (PERTH); 30 Aug. 2003, *Wildflower Society of W.A.* EURA26 (PERTH); 11 Oct. 2004, *C. Wilkins & J. Wilkins* CW 1984 (PERTH).

Distribution and habitat. Extends from Eurardy Station south-east to near Indarra (Figure 6A), in yellow to brown sand in varied vegetation dominated by mallees or high shrubs.

Phenology. Flowers from June to September. Fruits recorded in September and October.

Etymology. From the Latin *truncatus* (cut off, blunt-ended) after the more or less truncate young flower buds with strongly incurved sepals that lie almost flat across the top.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Listed with this priority by Smith and Jones (2018) under the name *S.* sp. Galena (W.E. Blackall 4728), this species is known from nature reserves and a national Park .

Co-occurring species. Recorded at one location (*Wildflower Society of WA* EURA 1) growing with *S. obovata* and at another (*B.L. Rye* 290165, *J. Norman & B. Parkhurst*) growing with *S. peltigera*.

Affinities. This is similar to several other species that have a peltate stigma, but most of those species have longer peduncles (2.5–15 mm *cf.* 0.5–2(–2.3) mm long). Three species with peduncles shorter than 2.5 mm long differ from *S. truncata* in having only 3–6 stamens per flower.

Notes. Currently *S. truncata* includes some specimens with somewhat pitted hypanthia (e.g. reference specimen of *S.* sp. Galena) as well as those with wrinkled ones (reference specimen of *S.* sp. Ajana East Road) but a few specimens are hard to classify into either category because they are somewhat intermediate in hypanthium patterning. This kind of difference in hypanthium patterning has proved useful in distinguishing some members of the genus and is used in the key, but in this case does not appear to be correlated with any other characters that could be used to recognise more than one species. Consequently the two phrase names are considered to be conspecific. *Scholtzia truncata* keys out at two positions (see key to species above) because of this variability in hypanthium ornamentation.

Sepals are strongly incurved at all stages of flowering and fruiting. The fruits can be 2-seeded but mostly contain only one seed.

Scholtzia uniflora Rye, *sp. nov.*

Typus: east of Binnu, Western Australia [precise locality withheld for conservation reasons], 13 September 1978, *M.E. Trudgen* 2218 (*holo*: PERTH 03628167; *iso*: CANB, MEL).

Scholtzia sp. Binnu (M.E. Trudgen 2218), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 401 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 2 March 2018].

Shrub commonly 1.2–2.5 m high and 1.4–2 m wide; flowering branchlets with peduncles borne at 1–4 consecutive nodes, often with their flowers combined into a dense cluster. *Leaves* antrorse. *Petioles* 0.5–0.8 mm long. *Leaf blades* broadly or very broadly obovate, 2–4 mm long, 2.0–3.5 mm wide, entire; abaxial surface raised only near the middle, often with a flattened section along the midvein that contracts into a ridge distally, with lateral veins usually obscure, the oil glands in more than 3 rows on each side of midvein, with 5–7 glands in innermost rows. *Peduncles* 0–0.5 mm long, 0.4–0.6 mm wide, 1-flowered. *Bracteoles* 1.5–1.8 mm long. *Pedicels* 0.4–0.7 mm long. *Flowers* 5–7 mm diam. *Hypanthium* 1.8–2.0 mm long, wrinkled-rugose. *Sepals* transversely oblong to semicircular or deltate to depressed ovate, 0.7–1.3 mm long, entire, the outer ones smooth or slightly keeled; petaline margin 0.3–0.5 mm deep, entire. *Petals* 2.5–3.5 mm long, pale to medium pink. *Stamens* 15–17, in a continuous circle. *Longest filaments c.* 1 mm long. *Anthers* 0.4–0.5 mm long. *Ovary* inferior, 3-locular; ovules 1 per loculus. *Style c.* 1.6 mm long; stigma ± peltate. *Fruits* largely inferior, 2.2–2.3 mm long, 2.3–2.5 mm wide; sepals erect, but scarious margins incurved; petals deciduous. *Seeds* 1.3–1.4 mm long, 0.8–1.0 mm wide.

Diagnostic features. Among species that have a 3-locular ovary with 1 ovule per loculus, *S. uniflora* is distinguished by the following combination of characters: peduncles absent or up to 0.5 mm long, 1-flowered; stamens 15–17, in a continuous circle.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 2 Dec. 2004, *A.D. Crawford* 807 (MEL, PERTH); 16 Aug. 2001, *R. Davis* 9935 (CANB, PERTH); 1 July 2001, *J. Docherty* 62 (PERTH); 5 Dec. 1993, *M.E. Trudgen & M.R. Trudgen* MET 12011 (AD, BRI, K, NSW, PERTH).

Distribution and habitat. Occurs east of Binnu (Figure 4A), and has been recorded in yellow sand on the top of a dune, in *Actinostrobus* tall open shrubland.

Phenology. Flowers from July to September.

Etymology. From the Latin *unus* (one) and *-florus* (-flowered). Refers to the presence of only one flower on each peduncle. Of the species with one ovule per loculus, this is the only one that has consistently 1-flowered peduncles.

Conservation status. Priority Two under Conservation Codes for Western Australian Flora. Previously listed (Smith & Jones 2018) as Priority One under the name *S.* sp. Binnu (M.E. Trudgen 2218).

Co-occurring species. At one locality, *S. uniflora* was recorded growing with *S. thinicola*.

Affinities. Similar to *S.* sp. Nolba in having 15–17 stamens and a 3-locular ovary with one ovule per loculus. The fruits in both species are largely inferior and have a smooth, convex summit. *Scholtzia* sp. Nolba has larger leaves, multi-flowered peduncles and usually shorter sepals. All other species with 15 or more stamens have a 2-locular ovary with two ovules per loculus.

Scholtzia uniovulata Rye, *sp. nov.*

Typus: Midlands Road, 2.5 km north of Coorow, Western Australia, 28 August 2003, *B. Moyle & N. Gibson* BM 005 (*holo*: PERTH 08126291; *iso*: ?CANB, K, MEL).

Shrub 0.5–3(–4) m high, 0.3–3 m wide; flowering branchlets with peduncles borne at 1–6 consecutive nodes, often with their flowers combined into a dense cluster. *Leaves* antrorse to patent. *Petioles* 0.1–0.3 mm long. *Leaf blades* obovate or broadly obovate, (0.8–)1.3–2.8(–4) mm long, 1.2–1.6 mm wide, ± entire; abaxial surface raised towards the middle, often with a flattened section along the midvein that contracts into a ridge distally, with lateral veins obscure or sometimes visible, the oil glands in 1 or 2 main rows on each side of midvein, with 2–4 glands in innermost rows. *Peduncles* 0.8–2.5(–3.5) mm long, 0.3–0.45 mm wide, mostly 1–3-flowered. *Bracts* 0.8–1.5 mm long. *Pedicels* 0.5–0.8 mm long. *Flowers* 3.5–4.5 mm diam. *Hypanthium* 1.0–1.4 mm long, rugose-pitted. *Sepals* broadly or very broadly obovate to transversely elliptic, of varied length, entirely petaline, the innermost one 0.8–1.2 mm long. *Petals* 1.2–1.6 mm long, white or pale pink. *Stamens* 3–6, 0–2 opposite each sepal (commonly 5 in the arrangement 2,0,1,2,0 or sometimes with mostly fewer than 5). *Longest filaments* 0.2–0.4 mm long. *Anthers* 0.2–0.3 mm long. *Ovary* inferior, 1(2)-locular (rarely 2-locular in a majority of the flowers); ovules 1 per loculus. *Style* 0.5–0.8 mm long; stigma ± peltate. *Fruits* 2/3–3/4-inferior, 1.0–1.2 mm long, *c.* 1.3 mm wide; sepals erect or spreading; petals deciduous. *Seeds* 0.7–0.8 mm long, 0.8–1.0 mm wide. (Figure 1D)

Diagnostic features. Among the species with 1 ovule per loculus, *S. uniovulata* is distinguished by its usually 1-locular ovary. Other important characters: hypanthium pitted; stamens 3–6.

Selected specimens examined. WESTERN AUSTRALIA: Yuna, Sep. 1930, *E. Ashby s.n.* (ADW, NSW); in a dip in Cunderdin–Minnivale Rd, 0.8 km N of Berry Rd, Minnivale Nature Reserve, 15 Oct. 2013, *R. Davis & B.L. Rye* DR 012 (PERTH); Wilroy, 17 Aug. 1964, *J. Galbraith* WA383 (MEL); Cowcowing, Sep.–Oct. 1904, *M. Koch* 1091 (AD, NSW); 7.1 km E of Konnongorring Siding on Dowerin–Konnongorring Rd, *c.* 27 km SW of Wongan Hills, 22 June 1996, *T.R. Lally & B.J. Lepschi* TRL 1029 (CANB, PERTH); 6.1 km on road to Ellendale Pool from Walkaway–Nangetty Rd, 26 Oct. 2001, *S.J. Patrick* 4084 (PERTH); Corrigin to Quairading, 28 Sep. 2002, *M.E. Trudgen* 21783 (AD, BRI, MEL, NSW, PERTH).

Distribution and habitat. Extends from the Greenough River area south-east to near Corrigin (Figure 5B), usually in sandy soils, occasionally with laterite or gravel. Occasionally the species occurs along watercourses, where it has been recorded reaching heights of up to 4 m or possibly more.

Phenology. Flowers from June to November.

Etymology. From the Latin *unus* (one) and *ovulatus* (having ovules). Refers to the presence of only one ovule in each loculus of the ovary and frequently only one ovule per ovary as the ovary is usually unilocular.

Vernacular name. Common Scholtzia. *Scholtzia uniovulata* appears to be distributed over the greatest area in the genus, although the coastal species *S. obovata* has a longer range if *S. umbellifera* is treated as its synonym.

Conservation status. Being one of the most common species in the genus, *S. uniovulata* is not considered to be at risk.

Chromosome number. *n* = 11, *fide* B.L. Rye, *Austral. J. Bot.* 27: 571 (1979) [as *Scholtzia parviflora*]. Voucher: *B.L. Powell* 73128.

Affinities. Many herbarium specimens have previously been identified as either *S. parviflora* or *S. oligandra*, both of which have an excluded syntype that matches this new species (see Rye 2017). *Scholtzia oligandra* is not closely related, differing in having a 2- or 3-locular ovary with two superposed ovules in each loculus. *Scholtzia parviflora* is very similar in morphology to *S. uniovulata*, but has more uniform sepals, with the innermost one 0.3–0.6 mm long (*cf.* 0.8–1.2 mm), a consistently 2-locular ovary, and usually larger leaves.

Most specimens of *S. uniovulata* are distinguished from those of all other species of *Scholtzia* by having a 1-locular ovary with a single ovule, but the much rarer specimens with a 2-locular ovary in all or most flowers are fairly widely dispersed.

Co-occurring species. No confirmed cases of co-occurrence are recorded on PERTH herbarium specimens but *S. uniovulata* is a widespread species that overlaps in range with many others.

Notes. Many specimens have tiny leaves less than 1.3 mm long on most of their branchlets, although all specimens have at least a few leaves greater than 1.3 mm long. Leaves 3–4 mm long are atypical and have only been observed on very fast-growing shoots. Despite the large number of specimens available for study at PERTH, only one could be found with fully mature, fertile fruits.

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A revision of the tiurndins (*Tribonanthes*, Haemodoraceae)

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Abstract

Hickman, E.J. & Hopper, S.D. A revision of the tiurndins (*Tribonanthes*, Haemodoraceae). *Nuytsia* 30: 87–154 (2019). The tiurndins (*Tribonanthes* Endl.) comprise a small taxonomically challenging genus of geophytes endemic to the Southwest Australian Floristic Region. Six named and one undescribed species of *Tribonanthes* are recognised in recent literature. *Tribonanthes* poses the most difficult taxonomic problems remaining for the Haemodoraceae in Western Australia. It is a genus where herbarium studies alone are insufficient to delineate taxa. A knowledge of variation in wild living material has proved essential to resolve taxonomic difficulties in the tiurndins. This revision recognises and comprehensively illustrates living plants of the 12 recognised species, four of which are new (*T. elongata* E.J.Hickman & Hopper, *T. keigheryi* E.J.Hickman & Hopper, *T. monantha* E.J.Hickman & Hopper and *T. porphyrea* E.J.Hickman & Hopper). *Tribonanthes variabilis* Lindl. and *T. uniflora* Lindl. are reinstated. Morphological and molecular data also support the recognition of three new subgenera: subg. *Tribonanthes*, subg. *Salina* E.J.Hickman & Hopper and subg. *Boya* E.J.Hickman & Hopper. Botanical illustration, especially of internal floral morphology, has revealed several previously unrecorded characters that help diagnose the species of *Tribonanthes*.

Introduction

Tribonanthes Endl. is a small, taxonomically challenging, genus of geophytes comprising some 12 species (this study) placed in Haemodoraceae subfamily Conostylidoideae (Lindl.) T.Macfarlane & Hopper. The genus is endemic to the Southwest Australian Floristic Region (SWAFR, *sensu* Gioia & Hopper 2017). *Tribonanthes* is currently placed in the monotypic Tribe Tribonantheae T.Macfarlane & Hopper, sister to all other members of the Conostylidoideae (Macfarlane & Hopper 1987; Simpson 1990; Hopper *et al.* 1999, 2009; Smith *et al.* 2011). Divergence of *Tribonanthes* has been estimated as occurring in the Eocene about 40 MA, with contemporary species diversifying since 5 MA (Hopper *et al.* 2009).

No common name has been adopted for the genus, except occasionally 'flannel flowers', which is confusing as it has been widely taken up for *Actinotus* Labill. in the Apiaceae. There is also no definitive Aboriginal name for members of *Tribonanthes* recorded in the literature or among extant Noongars SDH has interviewed over the past four decades.

Colonial botanist James Drummond (1842a: 4), in a discussion of the SWAFR's rich Haemodoraceae flora, mentioned a possible name, but left its application in doubt: 'There are two sorts of round white roots called *Jitta Cara* by the natives, which they sometimes eat; pigs also are fond of them. I cannot

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refer these plants with certainty to any described.' Grey (1840: 54) listed *Jeeta* as 'the root of a species of rush; this root is something like a grain of Indian corn in appearance and resembles it in taste. It is in season in June.' Moore (1884: 37) gave *jitta* as meaning 'the bulbous root of an orchis, eaten by the natives, about the size of a hazel nut', and *kara* was for 'a spider'. Some modern Noongars use *Kara* for *Burchardia congesta* Lindl. (Daw *et al.* 1997), with clusters of long slender white corms, but Drummond (1842b: 5) was clear that '*carra*' was applied to the much sought after orchid tuber of *Lyperanthus suaveolens* (= *L. serratus* Lindl.) in Western Australia. These alternative applications render the inferred application of *Kara* to *Tribonanthes* problematic.

Another similarly problematic name is *djoobak* (*djubak*, *dubak*, *joobak*, *jubak*, *tubac*, *tuboc*). Historically, this was applied to an edible small yam, usually of an orchid '... in season in .. October. The flower is a pretty white blossom, scented like the heliotrope.' (Moore 1884: 22). Resemblance to a hyacinth was suggested by Grey (1840: 33). Botanist James Drummond (1842b: 5) stated that '*Prasophyllum giganteum* produces the roots called '*tubac*' by the natives'. Modern Noongars apply the name to the orchid *Pyrorchis nigricans* (R.Br.) D.L.Jones & M.A.Clem. (Daw *et al.* 1997) but Yued elder Ned Mippy identified as *djoobak* specimens of *Tribonanthes longipetala* near Moora and New Norcia (Rooney 2002: 286). However, subsequently Rooney (2011: 125) gave a more general meaning for *djoobak* as a native potato, an 'edible kidney-shaped tuber species', and Wheatbelt Natural Resource Management (n.d.) similarly listed *djubak* as a general term for bush potato. Brandenstein (1988: 115) conveyed that some Esperance Noongars applied *tyuubaq* to the tubers of *Platysace effusa* (Turcz.) C.Norman (Apiaceae). It remains difficult to unequivocally apply this name to tubers of *Tribonanthes* species, with the weight of evidence pointing more towards *djoobak* traditionally being a name for a scented, multiflowered (like a hyacinth) edible orchid tuber.

Here, as a mark of respect to the indigenous people of the SWAFR, we propose instead that '*tiurndin*' is an apposite common name for the genus *Tribonanthes*. *Tiurndin* (pronounced churn-din) means 'fair, white (flowers)' according to Noongar informants from the Esperance region as recorded by von Brandenstein (1988: 101). Introduced sheep sometimes were also bestowed the same name, indicating that white wool may be regarded as meriting the label *tiurndin*. However, the first use of *tiurndin* was for white flowers, perhaps with a woolly appearance, which commends the name for most species of *Tribonanthes*. *Tiurndin* is derived from *Tyiurtt*, 'the ancestral hero involved in the creation of the southern coastline' (von Brandenstein 1988: 113), which is renowned for its brilliant white sand beaches. Indeed, *Tyiurtt's* name recurs in many forms where the colour white appears on the south coast, as in *chuditch* (white-spotted native cat), Mt *Chudalup* (a granite inselberg bedecked by white lichen), *maartyiurt* (white-pointer shark = hands white-tipped), *tyiurndur* (bright stars), and *Tyiurtigellup* (Lake Seppings at Albany, brilliantly reflecting white light on a still, cloudy day).

At present, six named and one undescribed species of *Tribonanthes* are recognised in contemporary literature (e.g. Parsons & Hopper 2003; Smith *et al.* 2011) and data bases maintained by the Western Australian Herbarium (1998-continuously updated). While some of these taxa are clear-cut, others are polymorphic and difficult to key out with the latest taxonomic treatment, now three decades old (Macfarlane 1987). Indeed, these taxonomic problems were evident to Bentham (1873: 426) who wrote from studies of specimens at the herbarium in Kew that: 'the species appear to be very variable and difficult to distinguish'.

We are currently involved in a broad study of the Haemodoraceae commenced in the 1970s (see Hopper *et al.* 2009 and references therein). This research soon identified the need to better understand taxonomic variation in *Tribonanthes*. Arguably, following recent resolution of tropical Kimberley *Haemodorum* Sm. species (Barrett *et al.* 2015), *Tribonanthes* poses the most difficult taxonomic

problems remaining for the family in Western Australia, although there remain undescribed taxa in other genera still to be dealt with (Smith *et al.* 2011). Until the alpha-taxonomy of *Tribonanthes* is resolved, molecular phylogenetic and other biological studies will be, and have been, significantly hampered (e.g. Hopper *et al.* 2009), with the need for collecting voucher herbarium specimens for such studies remaining critical. Indeed, the few biological investigations conducted on *Tribonanthes* have been accompanied by the lodgement of few or no vouchers (e.g. Pate & Dixon 1982), rendering their results difficult to ascribe to species today.

We have also been interested in exploring the use of modern techniques of botanical illustration as a means of discovering novel variation (Hickman *et al.* 2017). The contributions of botanical artists in discovery through illustration are rarely explicit in the literature. Here, we set out with the aim of having a botanical illustrator lead the research towards a taxonomic revision, and we make clear below what traits have been discovered through that process. Consequently, this paper focuses on a comprehensively illustrated revision of the genus *Tribonanthes*, with our combined efforts revealing the presence of 12 species, four of which are new and two reinstated.

Taxonomic history

If they were collected, no surviving specimens of *Tribonanthes* persist from the earliest maritime explorations of the SWAFR coastline, despite the genus being common enough around Perth, King George Sound and the Esperance region granites (Hopper 2003, 2004). The earliest scientific specimens extant were collected by Baron Karl A.A. von Huegel during the first 12 days of 1834 when at King George Sound. We know from his field journal that he ascended Mt Clarence on January 5th (Hopper 2004), and that *T. australis* Endl. occurs there today and on other nearby inselbergs such as Mt Melville.

The precise location of Huegel's collection was not documented. Endlicher (in Endlicher & Fenzl 1839) based comprehensive descriptions of the new genus and species on Huegel's collection. No comparison with other genera was made, other than the sequence in which the description appeared, but the diagnostic characters of *Tribonanthes* cited below were well-described. An illustration of *T. australis* was published by Endlicher in 1841 (Endlicher 1837–41) (Figure 1).

James Drummond, who arrived in the Swan River Colony in 1829, undoubtedly was aware of species of *Tribonanthes* well before Huegel. However, Drummond's earliest extant collections were made in 1839, some of which were used by Lindley (1839–40) as type material for *T. brachypetala* Lindl. (CGE 06823) and *T. longipetala* Lindl. (CGE 06824).

Lindley (1839–40) named two other new species – *T. variabilis* Lindl. based on Georgiana Molloy collections from the Vasse River (CGE 23342), and *T. uniflora* Lindl. (CGE 06825) from Captain Mangles' collections (or acquisitions from Drummond and others more likely – Hopper 2004). Lindley offered the rather disparaging comment that the tiurndins 'are plants of no beauty, as far as can be ascertained by their appearance in the form of dried specimens' (Lindley 1839–40: 44). Had he seen living plants, Lindley may have been more impressed by *Tribonanthes*.

Lindley's (1839–40) contribution was the first to reveal diversity amid seeming uniformity among the few herbarium specimens of *Tribonanthes* then available for study in Britain and Europe. This is a genus where herbarium studies alone are insufficient to delineate taxa. Field studies and dissection of living material are essential, we have found, to develop sound taxonomic insights for the tiurndins. Consequently, many herbarium collections have mixed material mounted on the same sheets.

Figure 1. Uncoloured engraving of *Tribonanthes australis* from a drawing of Hügel's King George Sound collection of this species by Putterlick, published by Endlicher in *Iconographia Generum Plantarum* (Endlicher, 1841) (Image from the Biodiversity Heritage Library. Digitised by [Field Museum Natural History Library] https://www.biodiversitylibrary.org/item/130502#page/235/mode/1up [accessed 5 May 2016]). This illustration, in its original publication, is the neotype of *T. australis*.

The type sheet of *T. variabilis* (CGE 23342), for example, includes one specimen of *T. longipetala* (second from left). All other specimens on the sheet are *T. variabilis*. Also, sketches of the stamen connective appendages at the bottom of the sheet show a *T. variabilis* stamen connective appendage on the left and a *T. longipetala* stamen connective appendage on the right. Lindley's original description of *T. variabilis*, based on this collection, mentions two length conditions; 'filamentis antherae subaequalibus dentatis v. petaloideis longioribus' (Lindley 1839–40: 44) hence the name *variabilis*, alluding to what Lindley perceived as the variable nature of the stamen connective appendages in this species.

Even more confusing is the type sheet of *T. uniflora* (CGE 08625) which includes three taxa. The single lectotype from Mangles on the left side of the sheet agrees well with Lindley's protologue, notably in having testicular (cormous) roots, the bract and upper leaf with noticeably membranaceous margins, and the anthers and filaments much shortened. On the right hand side, the Molloy collection from 'swamps, The Vasse' (River near Busselton) has the earliest extant representatives of one of the new species we name below as *T. porphyrea* E.J.Hickman & Hopper (if stamen connective appendages are cream), or *T. elongata* E.J.Hickman & Hopper (if stamen connective appendages are yellow). A solitary plant embedded in this collection, second from the right, labelled 'A' and determined in 1984 as *T. violacea* Endl. by T.D. Macfarlane, is another new species collected by Mrs Molloy that we name below as *T. keigheryi* E.J.Hickman & Hopper.

Endlicher (1846) published a new taxon (*T. violacea*, MEL 104289) based on collections of Ludwig Preiss made in October 1840 between Mounts Elphinstone and Melville at King George Sound (Albany). Endlicher erected new names for species already described by Lindley (1839–40) using Preiss specimens from Perth as types, thus creating the synonyms *T. odora* Endl. (= *T. brachypetala*) and *T. lindleyana* Endl. (= *T. longipetala*).

George Maxwell, during or before 1873, on one of his expeditions eastwards from Albany discovered at Cape le Grand more *Tribonanthes violacea* (e.g. K 000356594, incorrectly determined as *T. uniflora*). On this same sheet are two specimens collected by Georgiana Molloy in 1841 at the Vasse River (K 000356593). The left-hand specimen is more of the earliest extant collection of one of the new species we name below as *T. porphyrea* or *T. elongata* while the right-hand specimen is of the slender swamp-dwelling *T. keigheryi*.

Additional complexity on this sheet is evident in a single specimen (K 000356595) collected by Augustus Oldfield in 1873 at the Kalgan River north of Albany. This is correctly determined as *T. uniflora*.

Several such mixed collections were available to Bentham (1873), who correctly used Lindley's (1839–40) four earlier names and effected the relevant synonymies for Endlicher's (1846) later names. Moreover, Bentham, without the benefit of field studies of living material, regarded *T. violacea* as a synonym of *T. uniflora*, and suggested that *T. variabilis* was 'perhaps a variety only of *T. australis*'. Understandably, given the limited and mixed material available to him, Bentham obfuscated as much as clarified the taxonomy of *Tribonanthes*.

Mueller (1872–1874), perhaps at the time unaware of Bentham's (1873) synonymies, supported Endlicher's (1846) *Tribonanthes* species rather than Lindley's (1839–40) which had priority. However, Bentham's (1873) treatment prevailed for close to a century until Geerinck (1969: 65) suggested that *Tribonanthes* had only three, problematic species (i.e. the type *T. australis* and two others not specified). No workers before or since Geerinck (1969) have agreed to such a conservative view of the number of species of tiurndins.

Macfarlane's (1987) *Flora of Australia* treatment, the first by a resident Western Australian botanist, achieved some clarification, although based on decisions informed by limited field work (Macfarlane *pers. comm.* 2014). He recognised four species among the six that Bentham (1873) had listed (*T. australis*, *T. brachypetala*, *T. longipetala*, *T. violacea*), and synonymised two – *T. uniflora* under *T. longipetala*, and *T. variabilis* under *T. australis*.

A year earlier, in 1986, one of us (SDH) with colleagues Sue Patrick and Andrew Brown from the then Department of Conservation and Land Management, had discovered an almost glabrous and stemless pink-flowered new species on a granite outcrop in the central wheatbelt. This was named *T. purpurea* T.Macfarlane & Hopper in the appendix of the *Flora of Australia* volume in which Macfarlane's (1987) treatment of *Tribonanthes* was published. Subsequently, a second striking new species was discovered by SDH (Hopper 6931, PERTH 07438761), accompanied by Stephen van Leeuwen, near Meckering in October 1988. This was a diminutive species, growing barely more than 3–5 cm tall, the smallest of any Haemodoraceae known. Four years later, in 2002, Mike Lyons collected this same undescribed species from near Pingrup and Lake King (Lyons & Keighery 2006), and it was named *T. minor* M.Lyons & Keighery.

Lastly, in 1997 a small-flowered and slender-stemmed taxon in swamps at Lake Muir was recognised as an undescribed species by G.J. Keighery and given the phrase name *Tribonanthes* sp. Lake Muir (G.J. Keighery & N. Gibson 2134). In recent times, then, *Tribonanthes* was regarded as comprising this unnamed species and six described species – *T. australis*, *T. brachypetala*, *T. longipetala*, *T. minor*, *T. purpurea* and *T. violacea*.

Methods

We have examined herbarium specimens of *Tribonanthes*, including types lodged at the Western Australian Herbarium (PERTH), and AD, BM, CANB, CBG, K NSW and MEL. Also images of types and specimens were examined through Global Plants (http://plants.jstor.org/) at B, E, L, LD, P, S and W. Opportunistic collections, photography and field notes of *Tribonanthes* were made by SDH since the 1970s during field work in the SWAFR. For this intensive revision, at least five geographically representative populations for each of the six described and one undescribed species were identified by EJH for field visits and collection of fresh material for illustration so that discernible variation within known species was covered. Not all populations were able to be relocated due to limited or incorrect GPS co-ordinate information (often due to retrospective or automated estimation) associated with the herbarium specimens, or historical habitat alteration or deterioration. During searches for target populations, if other *Tribonanthes* species were found, opportunistic collections were taken. A voucher herbarium collection was made for each taxon at each population and lodged at PERTH. Leaf material from specimens at each of the populations visited was collected for subsequent molecular analysis. The results (to be published elsewhere) were taken into account in making our taxonomic decisions.

Colour botanical illustrations of each species we recognised, including variants within species, were made from fresh specimens with or without the aid of a dissecting microscope. Whole plant, details of above ground and below ground parts, including dissections of flowers, capsules, leaves, corms and roots, were illustrated to discover and elucidate morphological character traits.

Measurements of quantitative character traits for each species were taken from dried pressed material (Figure 2). Flowers, inflorescence and floral bracts were removed and rehydrated prior to dissecting and measuring. Inflorescence and floral bracts were splayed out to measure width as shown in Figure

2. Measurements are presented as ranges compiled from specimens of several populations across the distribution of each species.

Descriptive terminology used herein follows that adopted by Simpson (1990, 1998, 2006). Specimens cited are a selection seen. For types, we use an exclamation mark (!) for those seen as specimens, 'image!' for those seen as images online and '*n.v.*' for those not seen.

The species concept applied is both morphological and biological, following that articulated by Hopper and Brown (2001), and first used by Darwin (1868). New species are recognised if they grow in populations (i.e. are not aberrant individuals within populations displaying normal variation), if they have traits or a combination of traits not seen in any previously named species, and especially if they grow with previously named species and produce few or no natural hybrids, the latter exhibiting evidence of partial or full sterility. Ecological data, including habitats occupied, were also determined through field survey and summary of the information provided from herbarium specimens examined. We were unable to conduct experimental tests of reproductive interactions of putative species. However, as an independent test of reproductive isolation, we sequenced DNA from each study population to search for genetic divergence or uniformity, as well as explore molecular phylogenetics.

To highlight discoveries made through illustration, examples are listed within figure captions below.

Distribution maps were compiled on a base phytogeographic map from Gioia and Hopper (2017) showing floristic districts and provinces for the SWAFR. Locations came from label details of specimens held at PERTH and determined by the senior author in line with this taxonomic revision.

Life Cycle and Comparative Morphology

Seedlings (Figure 3). Little has been published on seed biology and germination requirements. However, *T. australis* seed are recorded as germinating on average within 65 days of sowing, ranging from 55 to 103 days (Fryer 2006). Contractile roots of the germinating seedling pull the apex down into the soil soon after germination

Corms and roots. Colourless roots lacking rhizosheaths (Smith *et al.* 2011) are produced in the autumn just above the corms at a depth of 2–5 cm below soil level. Roots are simple (*T. variabilis*) or may have a covering of fine short or long colourless root trichomes, with the long trichomes having some sand-binding ability (*T. minor* and *T. purpurea*). Aerne-Hains and Simpson (2017) described the root anatomy of *T. australis* (? *T. variabilis*). They found the endodermal cell wall of the roots is not thickened. The ground tissue of the central vascular cylinder consists of small isodiametric cells, with thin cell walls. These isodiametric cells have peripheral globular tanniniferous deposits present. The roots have two xylem poles (diarch) with a single large vessel flanked by 10–12 small vessels on either side and only two groups of phloem alternating between the xylem archs. Roots wither during the onset of dry soil in late spring (Pate & Dixon 1982; Figure 3). Corms provide the sole organ of perennation over the dry summers. Parent corms are annually replaced, globoid to ovate, white, fully enlarged to 0.5–1.5 cm diameter by the end of spring as above ground parts wither and dry. In winter a replacement daughter corm is produced alongside the parent corm, usually at the end of a shortly descending dropper stem. Protection is afforded by a pale brown scarious covering remaining from the previous-year's corms and leaf bases.

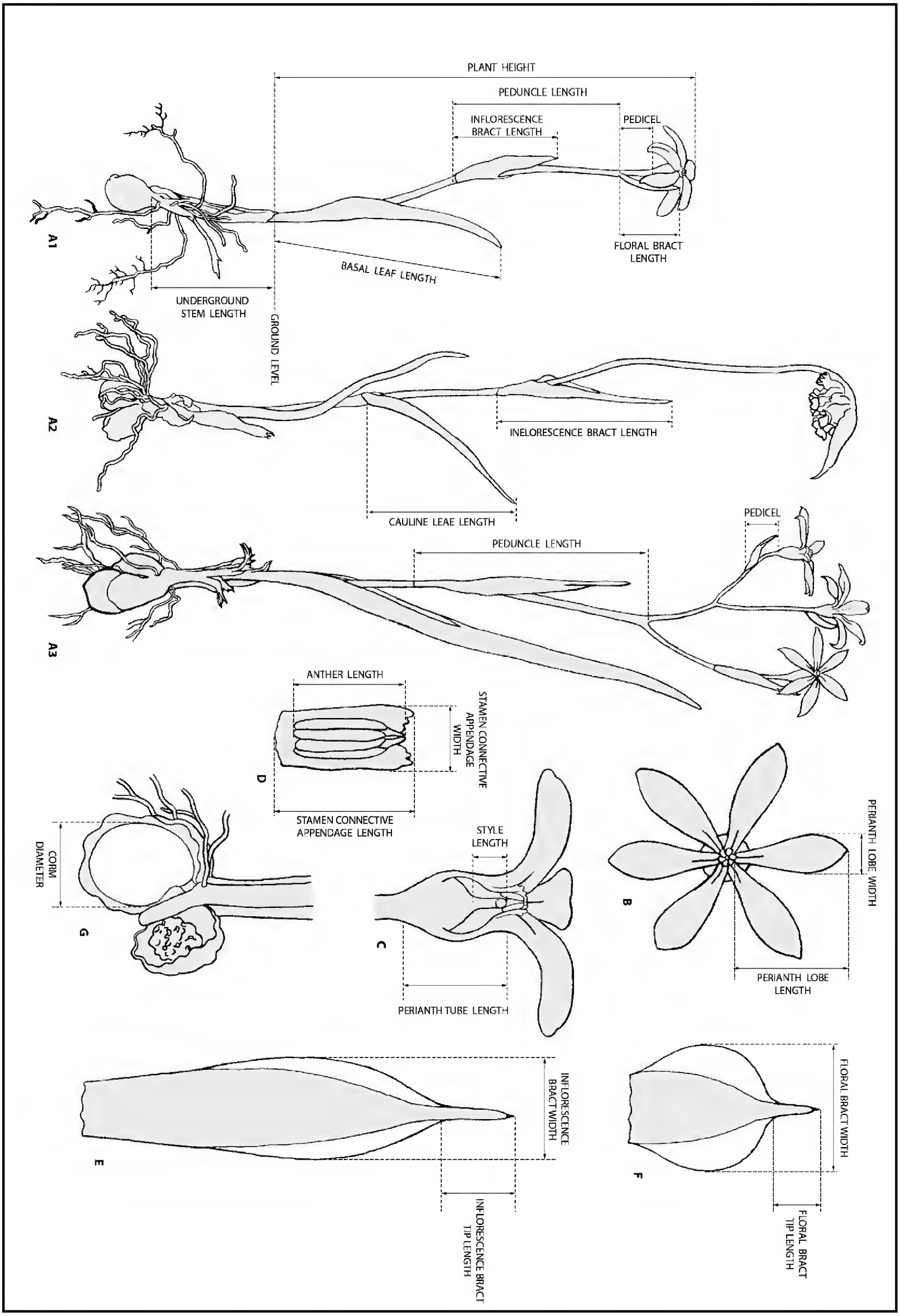

Figure 2. Caption opposite.

Flowering. Flowering has been claimed to be obligately fire-stimulated for all *Tribonanthes* species (Lamont & Downes 2011). However, several species found on granite outcrops flower in the absence of recent fire (e.g. *T. australis*, *T. brachypetala*, *T. monantha*, *T. purpurea*, *T. uniflora*, *T. variabilis*, *T. violacea*), as does the salt-lake endemic *T. minor* and species of ephemeral ponds such as *T. keigheryi*. Facultative flowering after fire is seen in species when they grow in other damplands such as *T. brachypetala* and *T. violacea* on paperbark (*Melaleuca* spp.) flats.

Aerial stem (Figure 4). The aerial stem is terete in cross section. It is glabrous from the basal leaf to the inflorescence bract, although sometimes there are scattered trichomes near the base of the inflorescence bract attachment, and then it is covered in woolly white trichomes above the inflorescence bract attachment to the base of the inflorescence, except *T. purpurea* which is glabrous throughout. *Tribonanthes brachypetala* and *T. variabilis* also possess a cauline leaf on the stem between the basal leaf and the inflorescence bract. Aerne-Hains and Simpson (2017) found in *T. australis* (? *T. variabilis*) that the aerial stem has a cortex of two to several cells thick, consisting of irregularly shaped cells. A sclerenchyma cylinder is present consisting of two to several cell layers, distinct from the adjacent cortical cells at the outer edge and grading into the parenchyma cells at the inner edge. Vascular bundles are inside the sclerenchyma cylinder, randomly arranged throughout, extending into the parenchyma but not found in the centre of it. Vascular bundles are often surrounded by sclerenchyma.

Basal leaves (Figure 4). These are 1.5–46 cm long (1.5–2.5 cm in *T. minor* and 2.5–5.5 cm in *T. purpurea*), basal (sub-basal to 7.5 cm above ground in *T. porphyrea*), narrowly linear to filiform (e.g. *T. keigheryi*), distinctly flat (e.g. *T. longipetala*), otherwise terete, with a long open basal sheath. The basal sheath has a narrow membranous margin, colourless or tinged pink to deep purple-red and no fringing trichomes. In Aerne-Hains & Simpson's (2017) study of the vegetative anatomy of Haemodoraceae, the epidermis of the leaf of *Tribonanthes australis* (? *T. variabilis*), *T. brachypetala* and *T. longipetala* (? *T. uniflora*) consisted of a single layer of cells. The epidermal cells are axially elongated, being longer than wide, with the cell body raised relative to the junction with the adjacent cells. Epidermal papillae are absent. Stomata are scattered across the leaf surface with each stomate having two paracytic subsidiary cells. The vascular bundles are arranged in a ring at the junction of the palisade and spongy mesophyll. Within the vascular bundles the xylem consists of two to 10 layers of vessels and phloem consists of two to eight layers of sieve members. *Tribonanthes* lack fibres enveloping the vascular bundles, which are usually present in the Haemodoraceae (Aerne-Hains & Simpson 2017). The cells of the bundle sheath are irregular and not surrounded by sclerenchyma. The palisade region contains scattered tannin cells. The leaves are fistulose with the spongy mesophyll containing aerenchymous cells, with the exception of *T. minor* and *T. purpurea*. The lack of fibres and presence of the aerenchyma cells in the leaves of *Tribonanthes* are consistent with features present in species that dwell in habitats that are at least periodically wet (Aerne-Hains & Simpson 2017).

Cauline leaves (Figure 4). *Tribonanthes brachypetala* and *T. variabilis* (not illustrated in Figure 2) often possess one or two cauline leaves between the basal leaf and inflorescence bract. It is shorter than the basal leaf, with a broad sheathing base and becoming terete above. The basal sheath has a narrow membranous margin, colourless or tinged pink to deep purple-red and no fringing trichomes. The apex is sometimes mucronate.

Figure 2 (opposite). Diagram of a *Tribonanthes* plant indicating quantitative characters measured (not to scale). A – whole plants including above and below ground parts; B – flower viewed from top; C – longitudinal section through flower; D – stamen showing anther and stamen connective appendage; E – inflorescence bract (splayed out) showing transparent margins; F – floral bract (splayed out) showing transparent margins; G – longitudinal section through underground corms showing this seasons corm, last seasons shrivelled corm and downward extension of stem forming next seasons corm. Illustration by E.J. Hickman.

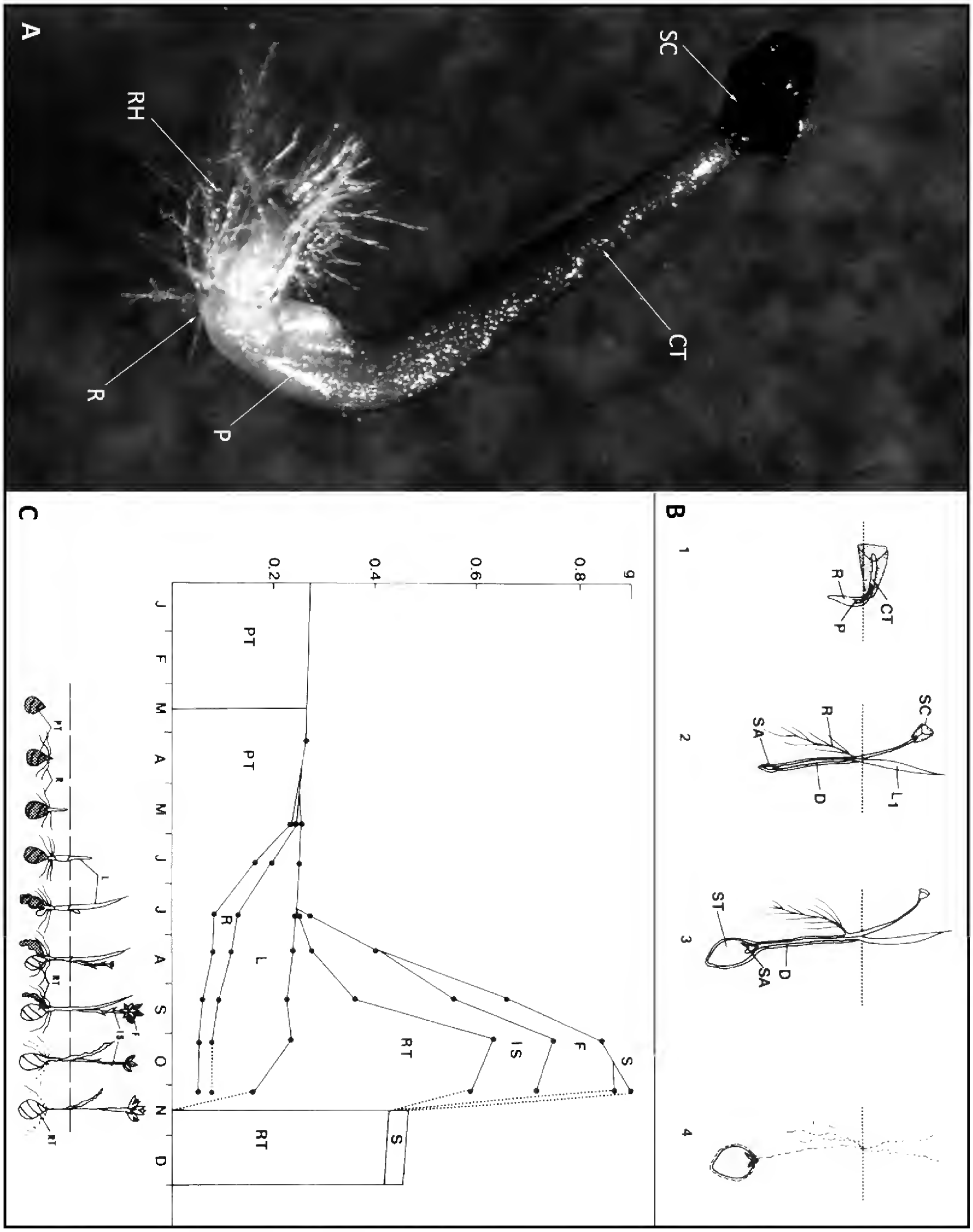

Figure 3. Seedling development and seasonal phenology of *Tribonanthes*. A – germinating seed of *T. keigheryi* (CT – cotyledon, P – plumule, SC – seed coat, R – radicle, RH – root hairs); B – seedling morphology of *T. variabilis*, showing mode of formation and burial of first-season's storage organs. Stages in seedling development are arranged in numbered sequence, the last stage showing the likely condition of the seedling on entering dormancy at the end of the first season of growth (CT – cotyledon; P – plumule; R – radicle; L1 – seedling leaf; SA – stem apex; SC – seed coat; D – 'dropper' shoot; ST – stem tuber). Ground level marked by a dotted line. (From Pate & Dixon 1982: 22-23); C – phenology of growth, dry matter production and reproduction in the geophyte *T. variabilis*. Morphological changes accompanying growth are recorded and provide a key to the symbols for plant organs used in the cumulative plots of change in dry matter of plant organs. A single parent stem tuber (stippled and marked PT) is replaced by a single replacement tuber (RT) (R – root; L – leaf; IS – inflorescence stem; F – flowers; S – seed). Total rainfall for the year of harvest was 923 mm. Long-term rainfall average for harvest site was 873 mm. (From Pate & Dixon 1982: 168). Image by R.J. Smith, Royal Botanic Gardens, Kew (A).

Inflorescence bract (Figure 4). The inflorescence bract is solitary. It is shorter than the basal (and cauline) leaf (0.6–13.8 cm). The bract is usually well-separated from basal leaves to a third or more up the stem, with a broad sheathing base and becoming shortly terete above. The apex is sometimes mucronate. The basal sheath has a broad membranous margin, and is colourless or tinged pink, lilac, or deep purple-red. In *T. australis*, *T. keigheryi*, *T. porphyrea* and *T. uniflora* the bract has trichomes along the margin.

Peduncle. The peduncle is the structure between the base of the inflorescence bract and the base of the floral bract (or lowest floral bract), with the exception of *T. longipetala*, with its conspicuous branching, where the upper limit of the peduncle is the lowest branching point (Figure 2). *T. longipetala* is anomalous in its open inflorescence with wide branching, which usually lacks a bract at the lower branch points. The base of the peduncle is the node at the base of the inflorescence bract.

Pedicel (Figure 4). Pedicel from the insertion of the floral bract to the base of the ovary. Pedicels are absent (e.g. *T. minor*) or vary in length up to 30 mm (e.g. *T. longipetala*).

Floral bracts (Figure 4). Inflorescences are either a solitary flower or a compact or loosely arranged cyme. A floral bract subtends each flower. The floral bracts are elliptic to orbicular. They have a terete tip which is sometimes mucronate. There are three to five prominent veins, broad membranous margins that are pale green or tinged pink or lilac, and fringed with colourless trichomes, except *T. purpurea* which is glabrous.

Flowers and perianth (Figure 5). Flowers are actinomorphic, slightly zygomorphic in *T. minor*, tubular, and with six perianth lobes. The lobes vary from narrow linear to broadly obovate. The perianth lobes can be longer than, equal or shorter than the perianth tube. They can be erect, spreading or strongly reflexed. The perianth tube is covered in silky or woolly white trichomes, sometimes tinged purple on the outer surface but the inner surface is glabrous and ranges in colour from white, pale green to a deep yellowish green. The perianth lobes are covered in silky or woolly white trichomes, sometimes tinged purple on both outer and inner surfaces, sometimes the centre of the outer surface has less trichomes and can have a central broad stripe that is either green or purple in colour. The exception is *T. purpurea* which has pink, glabrous flowers.

Stamen connective appendages (Figure 6). A distinctive feature of *Tribonanthes* is the presence of stamen connective appendages (Simpson 1990). Detailed developmental studies and homology issues require further studies to determine the anatomical origins of these structures. Their function is completely unknown. The stamen connective appendage includes the filament and the appendage, which are not easily distinguishable. The appendages consist of either two small lateral points at the top of the filament (e.g. *T. purpurea*, *T. keigheryi*), or a spreading apex of either short dentate points or more petal-like structures, sometimes with longitudinal ridges on the back (abaxial) surface, or a cluster of fleshy finger-like structures (*T. minor*, *T. monantha*), or a broad fleshy structure with dentate top and longitudinal ridges on the back surface (*T. brachypetala*). The stamen connective appendages are either white to cream or bright yellow in colour under natural light, aging to deep orange. The stamen connective appendages can be shorter than, equal to or project above the anthers, collectively forming a distinct corona-like structure.

Anthers (Figure 6). The anthers are yellow, except in *T. minor* in which they are cream. In terms of location of the anther on the stamen connective appendage, they appear centrally placed, or less frequently occupy the apical half (i.e. *T. keigheryi*, *T. purpurea*, *T. violacea*), or the basal half (i.e.

T. minor, *T. monantha*). The locules are free below the attachment and fused above with a sterile apex, whose function is unknown. They dehisce introrsely through longitudinal slits.

Pollen. *Tribonanthes* has globose-spherical pollen grains usually with 5 flattened apertures (sometimes 6–7) and scattered exinous elements (Simpson 1983; Pierce & Simpson 2009).

Styles and stigmas (Figure 6). The style is usually sub-sessile or short, stout and green, or with purple longitudinal striations, except *T. purpurea* where it is slender-filiform and elongated. The stigma is terminal, simple or has a prominent tuft of silky white trichomes at the apex (i.e. *T. elongata*, *T. longipetala*, *T. variabilis*, less so in *T. porphyrea*), or three protuberances at the apex (i.e. *T. brachypetala*, less so in *T. porphyrea*).

Nectaries. Simpson (1993) described *T. variabilis* as having three supralocular septal nectaries primarily traversing the exposed portion of its half-inferior ovary. They open to the outside at the extreme distal end of their extent, near the base of the style. They are composed of a single layer of radially elongated nectar-secreting epithelial cells. Ovary position influences the type and extent of nectaries, so other species of *Tribonanthes* may have different nectaries depending on their ovary position (Simpson 1993).

Ovary (Figure 7). The ovary is superior (i.e. *T. minor* and *T. purpurea*), inferior (i.e. *T. elongata* and *T. longipetala*) or otherwise half-inferior, except *T. variabilis* which can be half-inferior to inferior. The ovary consists of three locules. All species have axile placentation. The number of ovules per locule illustrated in Figure 7 was counted from available botanical drawings herein. It varied between different species: *T. brachypetala* (6 ovules); *T. purpurea* (7); *T. longipetala* (9); *T. minor* (10–12); *T. keigheryi* (14); *T. uniflora* (15); *T. monantha* (25); *T. elongata* (26); *T. variabilis* (26); *T. australis* (48); *T. violacea* (55); and *T. porphyrea* (78). *Tribonanthes brachypetala* displays early abortion of some ovules resulting in only a few seeds per capsule.

Capsule (Figure 7). All species have 3-valved capsules. The ovary swells as the seeds enlarge. The perianth is persistent, with the perianth lobes remaining reflexed or becoming erect, except *T. variabilis* where the perianth lobes remain spreading, prior to dehiscence. The perianth lobes then become reflexed post-dehiscence, except in *T. purpurea* where they are spread slightly from the erect position. When mature the capsule splits loculicidally from the apex to a third or half way down the central ridge of each carpel.

Seeds (Figure 7). Seeds of all species except *T. minor* are 1.0–2.2 mm in length, irregularly ovoid or cuboid with angular folds and a few ridges. The seed shape is affected by compression between neighbouring seeds during development. The seeds are brown tending to purple-grey, glabrous, with a starchy endosperm and a minute embryo near the micropyle. Those of *T. minor* are noticeably diminutive, measuring 0.4–0.5 mm in maximum length. The seeds have no specialised means of dispersal and appear to be released as capsules are shaken by wind and rain. Presumably the seeds do not fall far from the parent plant.

Chromosomes. Simpson (1990) reported N = 7 for an unknown *Tribonanthes* species. This chromosome count was attributed to "G.J. Keighery pers. comm." However, Hopper and Stone (cited in Hopper *et al.* 2006) obtained N = 11 for *T. variabilis* from Mt Benia and Toodyay Road. Moreover, G.J. Keighery (pers. comm. 2005) has no record of a count of N = 7 for *Tribonanthes*. The report of N = 7 for the genus was an error in Simpson (1990) (Simpson pers. comm. 2005). Subsequently, cytological collections by EJH of most species in the genus failed to yield squash preparations of pollen mother cells and root tips suitable for chromosome counts.

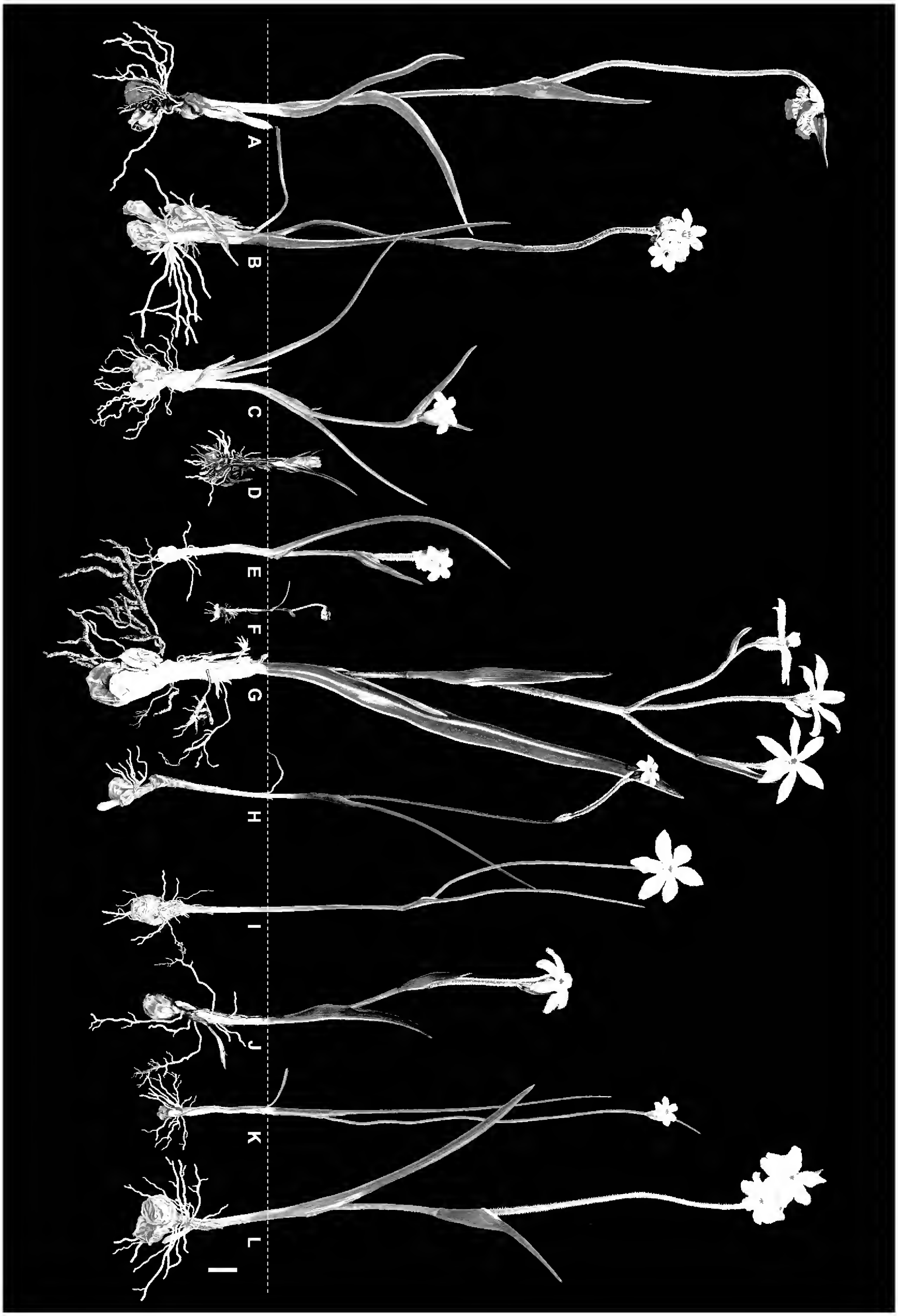

Figure 4. Caption on page 103.

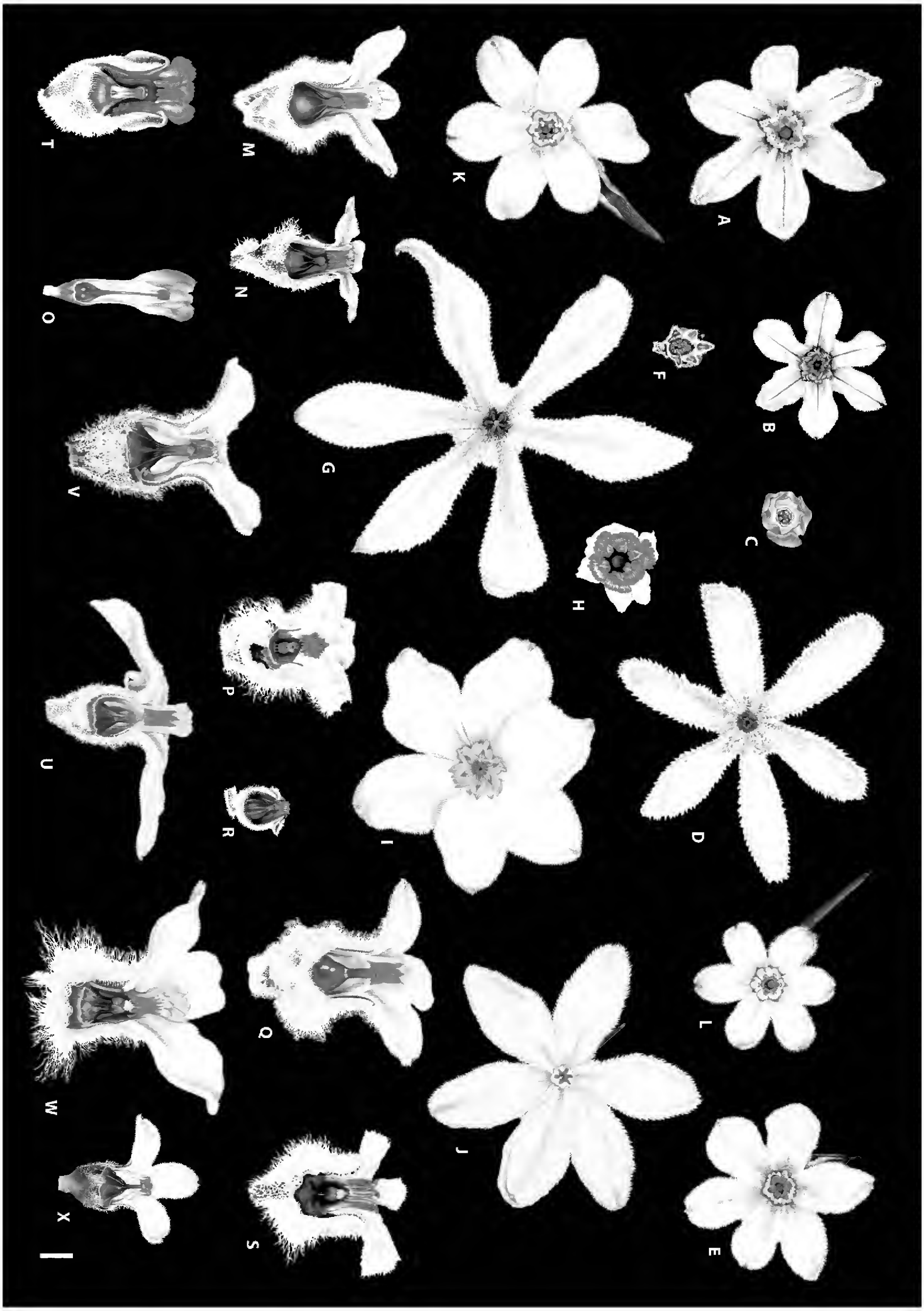

Figure 5. Caption on page 103.

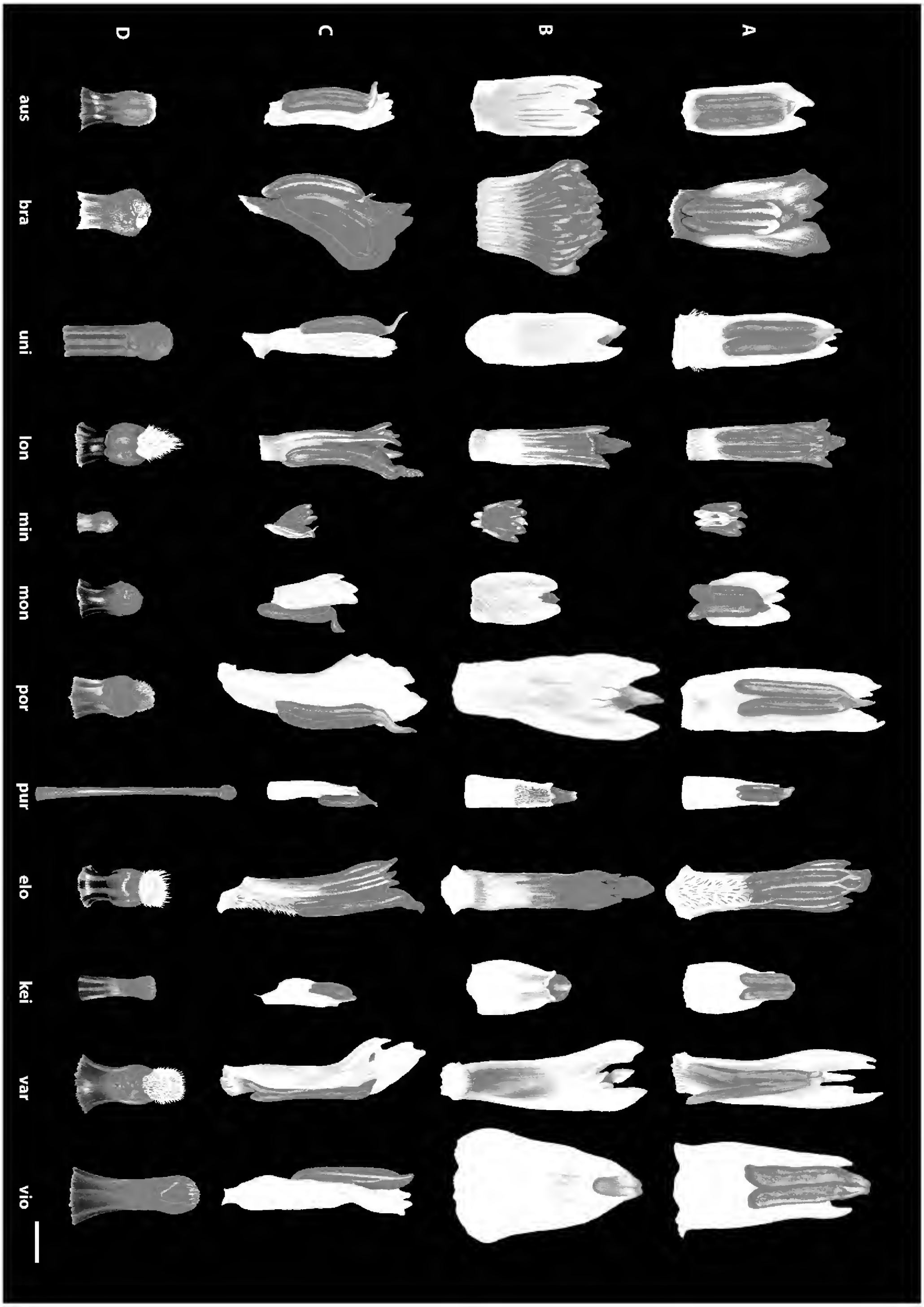

Figure 6. Caption on page 103.

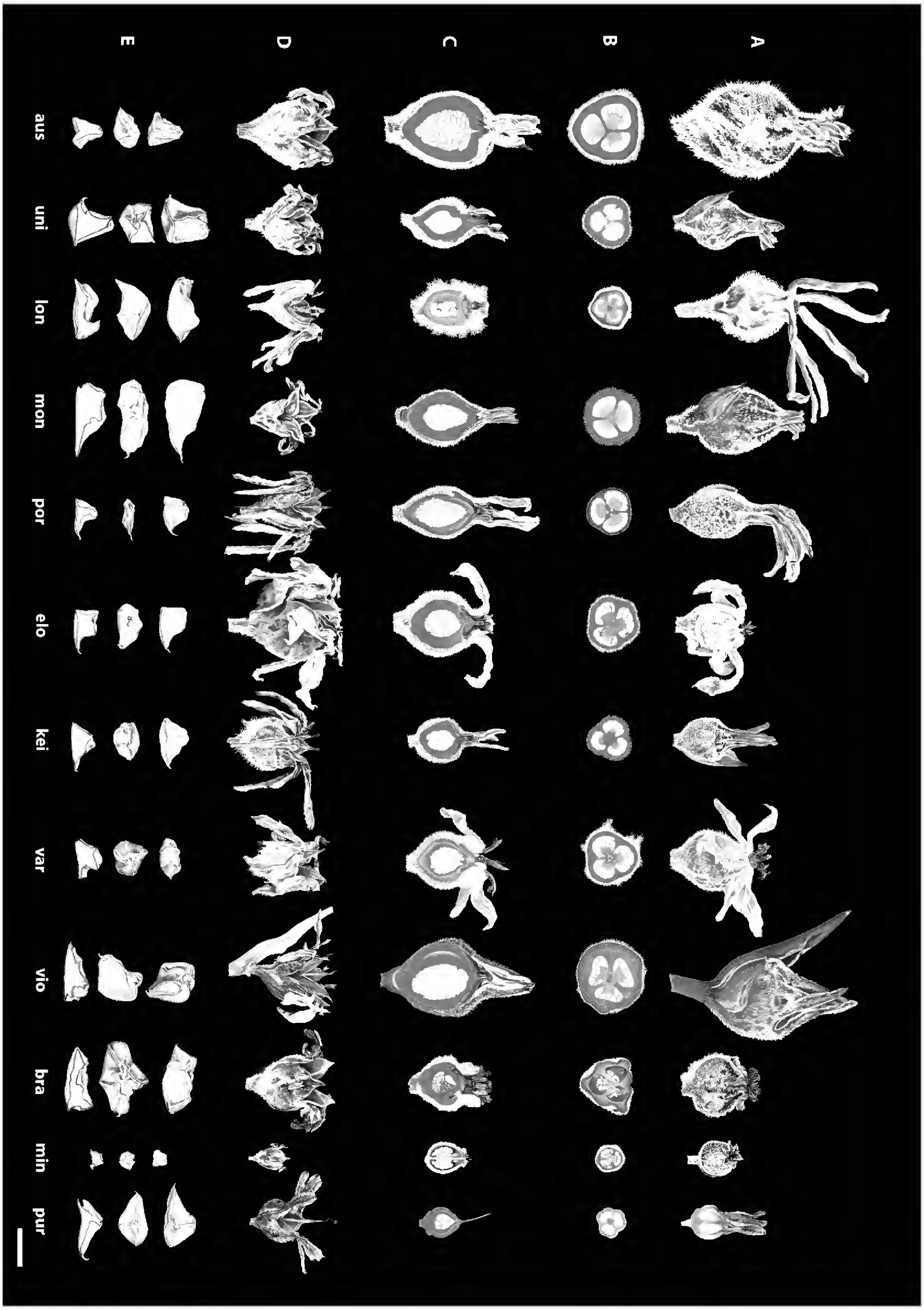

Figure 7. Caption opposite.

Figure 4 (page 99). Whole plant specimens of the twelve *Tribonanthes* species to scale (dashed line indicates ground level). A – *T. brachypetala* (no voucher, from Millinup Rd, south side of Porongurup Range after a fire in 2010); B – *T. australis* (*E.J. Hickman* 2067); C – *T. violacea* (*E.J. Hickman* 2090); D – *T. purpurea* (*E.J. Hickman* 2083); E – *T. uniflora* (*E.J. Hickman* 2084); F – *T. minor* (*E.J. Hickman* 2079); G – *T. longipetala* (*E.J. Hickman* 2021); H – *T. monantha* (holotype *E.J. Hickman* 2048; I – *T. porphyrea* (holotype *E.J. Hickman* 2025); J – *T. elongata* (holotype *E.J. Hickman* 2073); K – *T. keigheryi* (holotype *E.J. Hickman* 2065); L – *T. variabilis* (*E.J. Hickman* 2053). Scale bar = 20 mm. Discoveries through illustrations for particular species include the variation in peduncle length (species C, D, I and K have little to no peduncle, while all other species have relatively long peduncles); the sub-basal leaf up to 7.5 mm above ground level (species I). Illustrations by E.J. Hickman.

Figure 5 (page 100). Flowers of *Tribonanthes* species viewed from top or face-on (A–L) and with half perianth removed to show ovary position, stamen, stamen connective appendages and style (M–X). A – *T. australis*; B – *T. monantha*; C – *T. purpurea*; D – *T. elongata*; E – *T. uniflora*; F – *T. minor*; G – *T. longipetala*; H – *T. brachypetala*; I – *T. variabilis*; J – *T. porphyrea*; K – *T. violacea*; L – *T. keigheryi*. M – *T. australis*; N – *T. monantha*; O – *T. purpurea*; P – *T. elongata*; Q – *T. uniflora*; R – *T. minor*; S – *T. longipetala*; T – *T. brachypetala*; U – *T. variabilis*; V – *T. porphyrea*; W – *T. violacea*; X – *T. keigheryi*. Scale bar = 2.5 mm. Discoveries through illustrations for individual species include: difference in ratio of length to width of perianth lobes (particularly A>I and G>J distinguishing these species pairs); position of ovary (inferior – P, S, half-inferior – M, N, Q, T, U, V, X, superior – O, R, half-inferior to inferior – W). Voucher specimens as cited in caption for Figure 4. Illustrations by E.J. Hickman.

Figure 6 (page 101). Stamen and styles of *Tribonanthes* species. A – stamen viewed from front; B – stamen viewed from back; C – stamen viewed from side; D – style and stigma; aus – *T. australis*; bra – *T. brachypetala*; elo – *T. elongata*; kei – *T. keigheryi*; lon – *T. longipetala*; min – *T. minor*; mon – *T. monantha*; por – *T. porphyrea*; pur – *T. purpurea*; uni – *T. uniflora*; var – *T. variabilis*; vio – *T. violacea.* Scale bar = 1 mm. Discoveries through illustration for particular species include; colour of stamen connective appendages (cream – aus, uni, mon, por, pur, kei, var, vio; yellow – bra, lon, min, elo); colour of anthers (yellow – aus, bra, uni, lon, mon, por, pur, elo, kei, var, vio; cream – min); position of attachment of anther on stamen connective appendage (central – aus, bra, uni, lon, por, elo, var; lower – min, mon; upper – pur, kei, vio); trichomes on inner surface of filament (elo); relative length of style (sub-sessile – aus, bra, lon, min,mon, por, elo, var; short – uni, kei, vio; long – pur); style colour (green – bra, uni, min, por, pur, var; purple striations – aus, lon, mon, elo, kei, vio); stigma colour (yellow – aus, bra, uni, min, mon, por, pur, kei, vio; green – lon, elo, var); stigma vestiture (none – aus, uni, min, mon, pur, kei, vio; tuft of silky white trichomes – lon, por, elo, var; three protuberances – bra, por). Voucher specimens as cited in caption for Figure 4. Illustrations by E.J. Hickman.

Figure 7 (opposite). Capsules and seeds of *Tribonanthes* species. A – immature capsule; B – T.S. capsule; C – L.S. capsule; D – dehisced capsule; E – seeds from side top and sectioned to show seed volume; aus – *T. australis*; bra – *T. brachypetala*; elo – *T. elongata*; kei – *T. keigheryi*; lon – *T. longipetala*; min – *T. minor*; mon – *T. monantha*; por – *T. porphyrea*; pur – *T. purpurea*; uni – *T. uniflora*; var – *T. variabilis*; vio – *T. violacea*. Scale bars = 5 mm (A, B, C, D); 1 mm (E). Discoveries through illustration for particular species include persistent perianth position before dehiscence (erect – aus, uni, mon, por, kei, vio, pur; splayed– lon, elo, var; reflexed – bra, mon); persistent perianth position after dehiscence (reflexed – aus, uni, lon, mon, por, elo, kei, var, vio, bra, min; upwardly splayed– pur); ovules per locule (<10 – bra, pur, lon; 10–25 – min, kei, uni, mon; 25–50 – elo, var, aus; >50 – vio, por); the relative size of seeds particularly the diminutive *T.minor* seeds. Voucher specimens as cited in caption for Figure 4. Illustrations by E.J. Hickman.

Molecular Phylogeny

Early analysis of the molecular phylogeny of the Haemodoraceae included a few species of *Tribonanthes* (Hopper *et al.* 1999, 2009). Some of the identifications in these studies need updating in light of this present revision. This update is being done, and a more comprehensive study of all twelve species at up to eight populations each is underway.

Current evidence unequivocally establishes the monophyly of *Tribonanthes* as a genus (Hopper *et al.* 2009). Morphological, ecological and current unpublished molecular studies indicate strong support for recognition of *T. minor* and *T. purpurea* as monotypic subgenera.

It seems clear that further species-level resolution of the phylogeny of *Tribonanthes* and a clearer understanding of the role of natural hybridization in the genus will require next generation sequence data.

Taxonomy

Tribonanthes Endl. in S. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 4: 27 (1839). *Type*: *Tribonanthes australis* Endl.

Herbs, perennial terrestrial geophytes, erect (usually) but stemless or nearly so in *T. purpurea*, to 41 cm tall. *Corms* annually replaced at the end of a short, vertically descending dropper emergent near the top of the parent corm, globoid to ovate, white, to 0.5–1.5 cm diameter when fully enlarged, ensheathed with brown scarious papery multi-layered tunic. *Roots* annually replaced, emergent from the top of the corm, colourless, sinuous, lacking a rhizosheath, or sometimes with a loose sand-binding rhizosheath (*T. longipetala*), *c.* 1 mm diameter. Leaves 1(–3), usually 1 basal, occasionally additional leaves on aerial stem (*T. brachypetala*, *T. variabilis*); sheath cylindrical, closely (or loosely) surrounding the stem, dilated and funnel-like in upper part, with margins fused (or free); lamina terete, sometimes slightly grooved or flat, narrowly linear. *Inflorescence* terminal, a single flower, a compact or loose cyme, or bifurcate pair of helicoid cymes; axes lanate, bracts usually glabrous with hairy margins. *Flowers* actinomorphic, slightly zygomorphic in *T. minor*, white, sometimes tinged purple, rarely purplish pink (in *T. purpurea*). *Perianth* shortly tubular, white-lanate, the 6 lobes imbricate, divergent or reflexed at anthesis. *Stamens* 6, inserted at base of the perianth lobes; filament connective extended upwards as an apically lobed, fleshy, yellow or cream flange often irregularly serrate at top; *anthers* dorsifixed with sterile apex, dehiscence longitudinal. *Ovary* inferior, half-inferior or superior, globose, with few to numerous ovules (*c.* 6–80 per locule), anatropous or heterotropous, the roof green. *Style* broadly conical or slender-filiform; stigma capitate, yellow or green, obscurely 3-lobed with elongate apex sometimes tufted with short trichomes or topped with 3 protuberances. *Capsules* enlarged, ellipsoidal, loculicidally dehiscent. *Seeds* globose or cuboidal angular, often irregular and variable in the one capsule, purplish grey-brown.

Etymology. From the Greek *tribon* (threadbare cloak) and *anthos* (flower), which could refer to the cobwebby-woolly indumentum of the flowers of most species (Macfarlane 1987) or to the stamen connective appendages 'which rise above the anthers' (Sharr 1996: 69).

Notes. *Tribonanthes* is a taxonomically isolated genus within Haemodoraceae subfamily Conostylidoideae (Lindl.) T.Macfarlane & Hopper, placed in its own monotypic tribe Tribonantheae (Macfarlane & Hopper 1987; Simpson 1990; Hopper *et al.* 1999, 2009; Smith *et al.* 2011). The 12 species share a common ecology as inhabitants of seasonally water-logged or shallowly inundated clay-based wetlands or seeps and moss mats on granite outcrops. These are often old, climatically-buffered infertile landscapes (Hopper 2009; Hopper *et al.* 2016), refugial habitats from today's strongly seasonal Mediterranean climate, implying that ecological niche conservatism is a hallmark of *Tribonanthes*.

The genus is most diverse in higher rainfall provinces of the SWAFR (Gioia & Hopper 2017), with a few species penetrating further inland in locally mesic habitats afforded by granite outcrops or seasonal damplands. Occupying such habitats are the two smallest species, the granite pink (*T. purpurea*) and the diminutive salt-lake tiurndin (*T. minor*). These are the only taxa of conservation concern. Their population structures are quite insular, and their habitats at some risk to disturbance processes affecting granite outcrops and freshwater rises on the margins of salt lakes respectively. In particular, threats include grazing by native mammals and feral rabbits and pigs, mechanical disturbance of granite moss mats by recreational or mining vehicles, the risk of salinization due to land clearing and climate change, and invasion of habitats by weeds.

Based on our field, morphological and molecular studies it is reasonable to recognise three subgenera in *Tribonanthes*, two of which are monotypic; they are keyed out below.

Key to subgenera of *Tribonanthes*

1. Perianth white with spreading or reflexed lobes

2. Aerial stem up to 3 cm tall .... subg. **Salina**

2: Aerial stem longer than 5 cm tall .... subg. **Tribonanthes**

1: Perianth purple-pink with erect lobes .... subg. **Boya**

Key to species of *Tribonanthes*

Note. Species are listed by relatedness, based on our morphological studies and initial results from continuing molecular studies, and numbered consecutively below for the entire genus.

1. Inflorescence multi-flowered

2. Stamen connective appendages white to cream

3. Stigma glabrous or few scattered trichomes .... **1. T. australis**

3: Stigma with tuft of trichomes .... **8. T. variabilis**

2: Stamen connective appendages yellow

4. Perianth lobes spreading .... **3. T. longipetala**

4: Perianth lobes strongly reflexed .... **10. T. brachypetala**

1: Inflorescence 1(–2) flowered

5. Stamen connective appendages yellow

6. Perianth lobes spreading .... **6. T. elongata**

6: Perianth lobes strongly reflexed .... **11. T. minor**

5: Stamen connective appendages white to cream

7. Stamen connective appendages residual

8. Perianth lobes erect, glabrous .... **12. T. purpurea**

8: Perianth lobes spreading, hairy

9. Inflorescence bract sheath margin hairy, fine slender plant, swamp dweller .... **7. T. keigheryi**

9: Inflorescence bract sheath margin glabrous, robust plant, granite dweller .... **9. T. violacea**

7: Stamen connective appendages prominent

10. Stigma with tuft of trichomes .... **5. T. porphyrea**

10: Stigma glabrous or few scattered trichomes

11. Inflorescence bract sheath margin glabrous .... **4. T. monantha**

11: Inflorescence bract sheath margin hairy .... **2. T. uniflora**

Tribonanthes Endl. subg. **Tribonanthes**

Aerial stem more than 5 cm tall. *Flowers* erect, solitary or few per inflorescence. *Perianth* with white spreading lobes, or with green reflexed lobes. *Style* 0.4–3.2 mm long.

Notes. A subgenus of ten species regarded as the typical tiurndins with white lanate erect (rarely nodding, i.e. *T. brachypetala*) star-like flowers. Found on granite outcrops or seasonal damplands or in shallow pools.

1. Tribonanthes australis Endl. in S. Endlicher & E. Fenzl, *Nov. Stirp. Dec.* 4: 27 (1839).

Type: King George Sound, Western Australia, *C. Hügel s.n.* (*holo*: W, *n.v.* – destroyed in fire during World War II [E. Vitek *pers. comm.* 6 May 2016]). *Neotype* – illustration in S. Endlicher, *Icon. Gen. Pl.* t. 109 (1841), here chosen (Figure 1).

Illustrations. S. Endlicher, *Icon. Gen. Pl.* t. 109 (1837–41) – Fig. 1.; A. Schnizlein *Iconogr. i.* t. 62 Fig. 4 (1843); W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); J. Scott & P. Negus *Wildfl. Aust. S.W.* p. 44 Fig. 5 (2002).

Herb annually renewed from a white ovoid corm, 17–41 cm tall, consisting of a single stem and single basal leaf. *Corms* 10–12.5 mm diameter, covered by numerous old brown, papery sheaths, 3.2–8.9 cm below soil surface. *Roots* white, simple with no visible root trichomes and no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 2.6–29.4 cm, glabrous. *Basal leaf* 8–23 cm long, erect, stem-clasping to terete, red-purple base grading to deep green apically, with dark mucronate tip, glabrous. *Inflorescence bract* 2.7–10.8 cm long, erect, funnel-like sheath with broad dilated mouth, 6–10 mm circumference at widest point, green with noticeable longitudinal veins and thin scarious margins fringed with white trichomes; lamina 10–61 mm long, terete, green, with darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to floral bract) 7.5–26 cm long, covered in white woolly trichomes, sparser towards inflorescence bract. *Inflorescence* a compact cyme of 2–5 sessile or shortly pedicellate flowers, each subtended by a single floral bract. *Floral bract* ovate, 5–11 mm long, 2–7 mm wide, greenish-purple with prominent longitudinal veins, hairy on margins and at base outside, glabrous inside, with a short terete mucronate apex, 1–2 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 5–9.1 mm long, 2–4.8 mm wide, spreading, obovate to elliptic, inner surface white hairy, outer surface purple with white trichomes sparser along centre of lobe, tips dark mucronate. *Perianth tube* 3–7 mm long, outer surface covered in long silky white trichomes, inner surface pale green, glabrous. *Stamen connective appendages* 2–4 mm long, 1.3–1.5 mm wide, creamy white, topped with 4 or 5 finger-like projections with rounded tips, equal to slightly exceeding anther tips. *Anthers* 1.5–3.3 mm long, yellow, with cream sterile apex that projects towards centre of flower, attached centrally on stamen connective appendages. *Ovary* green, half-inferior, locules 3, with many (48) ovules per locule. *Style* 0.6–2 mm long, with green and purple longitudinal striations. *Stigma* yellow, with few scattered trichomes on upper surface. *Capsule* with perianth persistent, erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 1, 8, 9)

Diagnostic features. Tall plant, terete leaf, long peduncles, multi-flowered inflorescence, white hairy flowers with faint tinge of purple, large creamy white stamen connective appendages, short to sub-sessile style with simple stigma bearing few scattered trichomes on upper surface, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: 7.2 km W of Denmark along South Coast Hwy, 18 Sep. 1991, *A.R. Annels* 1668 (PERTH); Kangaroo Rd, 4.1 km E of Collis Rd, Hazelvale, 14 Sep. 1994 *A.R. Annels & R.W. Hearn* 4416A (PERTH); banks of the Gordon River, N of Frankland, 13 Sep. 1973, *A.M. Ashby* 4899 (PERTH); Holland Rocks, 4.4 km from Newdegate–Pingrup Rd along Holland Tank Rd, 17 Sep. 2014, *A.M. Coates* 6735 (PERTH); road to water monitor, Waychinicup, E of Albany, 30 Oct. 1992, *E.J. Croxford* 6659 (PERTH); Table Hill Forest Block, Bevan Rd Denbarker, 8 Oct. 2007, *C.P. Dornan* 387 (PERTH); Nollajup Nature Reserve, 8 km SW Boyup Brook, 20 Sep. 2014, *E.J. Hickman* 2057 (PERTH); Mettabinup Nature Reserve, 3.3 km W on Flora and Fauna Rd from Tone Rd, then 500 m into reserve to SW boundary of reserve, 20 Sep. 2014, *E.J. Hickman* 2060 (PERTH); Wamballup Lake Nature Reserve, 500 m W on Wamballup Rd from Boyup Rd, S side of road in broad drainage line, 30 Sep. 2014, *E.J. Hickman* 2066 (PERTH); Mt Melville, 350 m SE from top carpark along Mt Melville Circuit Trail, both sides of trail, 31 Oct. 2014, *E.J. Hickman* 2067 (PERTH); 20 km S of Bridgetown towards Manjimup, 8 Oct. 1982, *G.J. Keighery* 5346 (PERTH); Porongurup Range, SW margin, below Halls Rock, 3 Nov. 1986, *G.J.Keighery* 8481 (PERTH); Moingup Spring, Chester Pass, Stirling Range, 20 Sep. 1987, *G.J. Keighery* 11382 (PERTH); Symmonds Block, Tuart Forest, W of Ludlow, 15 Sep. 1994, *G.J. Keighery* 13595 (PERTH); Cowerup Nature Reserve, 23 Oct. 1997, *G.J. Keighery & N. Gibson* 2749 (PERTH); 3 km E of Windy Harbour, 13 Nov. 1986, *M. Prest s.n.* (PERTH); Scott National Park camping reserve west, 17 Sep. 1990, *C.J. Robinson* 123 (PERTH).

Proposed vernacular name. Southern Tiurndin.

Phenology. Flowers from August to December.

Distribution and habitat. The species ranges from Augusta across the south-west corner of Western Australia to east of Albany, with an out-lying population recently recorded near Hollands Rock. It is mainly concentrated in the Jarrah and Muir Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), but there are collections from the Fitzgerald-Stirling and Maalak Districts of the Southeast Coastal Province. *Tribonanthes australis* grows on brown loams around granite outcrops associated with herbfields, shrublands and open woodlands, and on grey sandy clay in winter wet flats associated with shrublands and heathlands adjacent to open woodlands. Associated species include *Corymbia calophylla*, *Eucalyptus rudis*, *Eucalyptus wandoo*, *Melaleuca preissiana*, *Melaleuca viminea*, *Hakea prostrata*, *Taxandria marginata*, *Verticordia plumosa*, *Borya nitida*, *Drosera menziesii*, and *Stypandra glauca* (Figure 9).

Conservation status. Widespread with no special conservation needs.

Etymology. Named from the Latin for southern, alluding to its discovery at King George Sound near the southern-most part of the Swan River Colony.

Notes. Macfarlane (1987) synonymised *T. variabilis* under *T. australis*. However, while the stigma of *T. australis* can sometimes have scattered trichomes on the top, the prominent appendage covered in silky white trichomes, present on the stigma of *T. variabilis*, is absent. Also the perianth of *T. australis* is more noticeably tinged purple than the perianth of *T. variabilis*, and the perianth lobes of *T. australis* are generally narrower than *T. variabilis*, relative to their length. *Tribonanthes australis* is usually more south and east in its distribution (Figure 9C) while *T. variabilis* is found on the west coast (Figure 23C). Young plants of *T. australis* may appear to have a single-flowered inflorescence, and hence are confused with their smaller relatives, *T. monantha* and *T. uniflora*. *Tribonanthes australis* is identified as a herbaceous species in the floristic summary of the *Melaleuca cuticularis/M.preissiana* Open

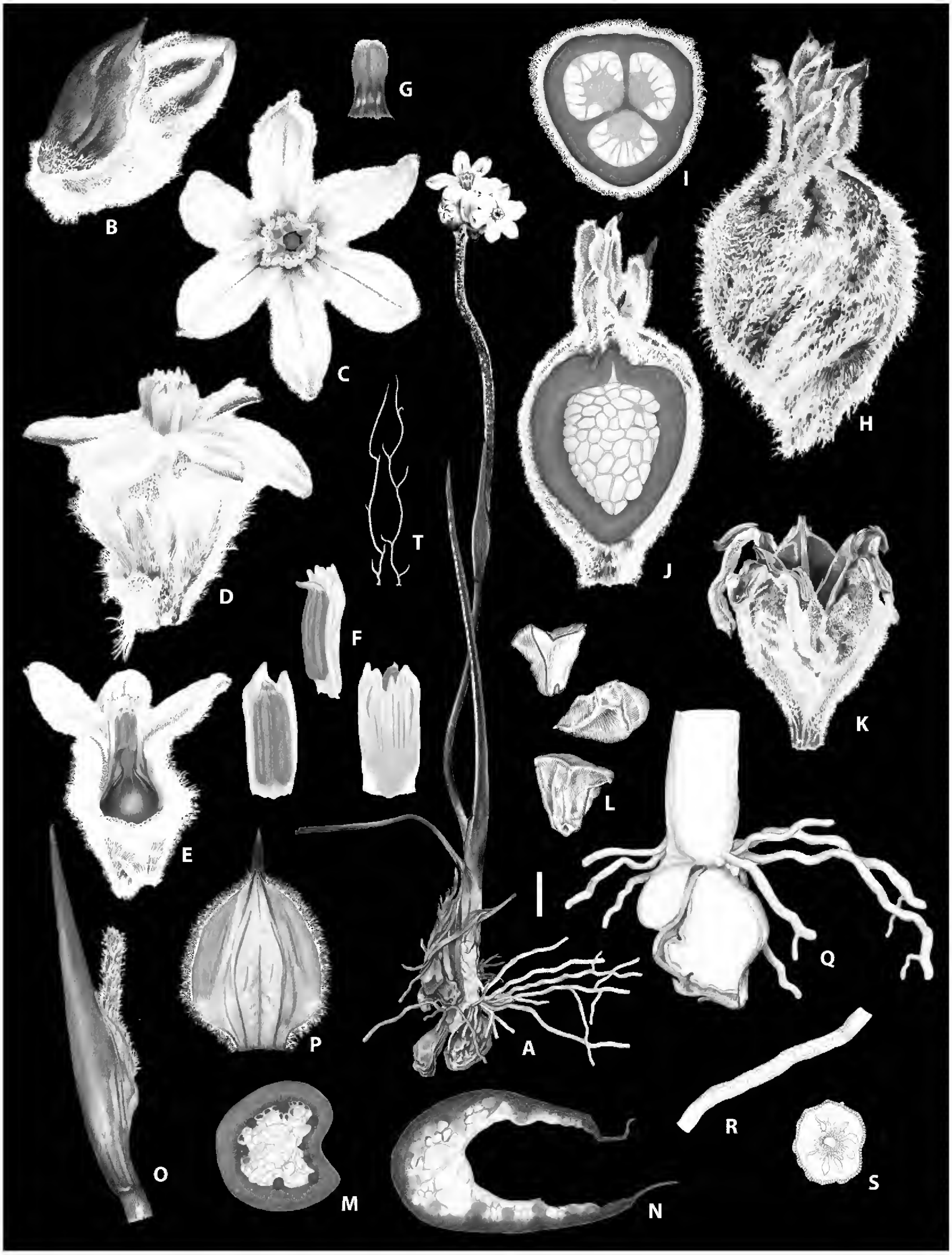

Figure 8. *Tribonanthes australis*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting forwards; G – style sub-sessile with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, H, I, J, K, P, R); 1 mm (F, G, M, N); 4 mm (O, Q); 0.5 mm (L, S); 0.65 mm (T). Drawn from fresh material of *E.J. Hickman* 2067 (PERTH 08989354). Illustrations by E.J. Hickman.

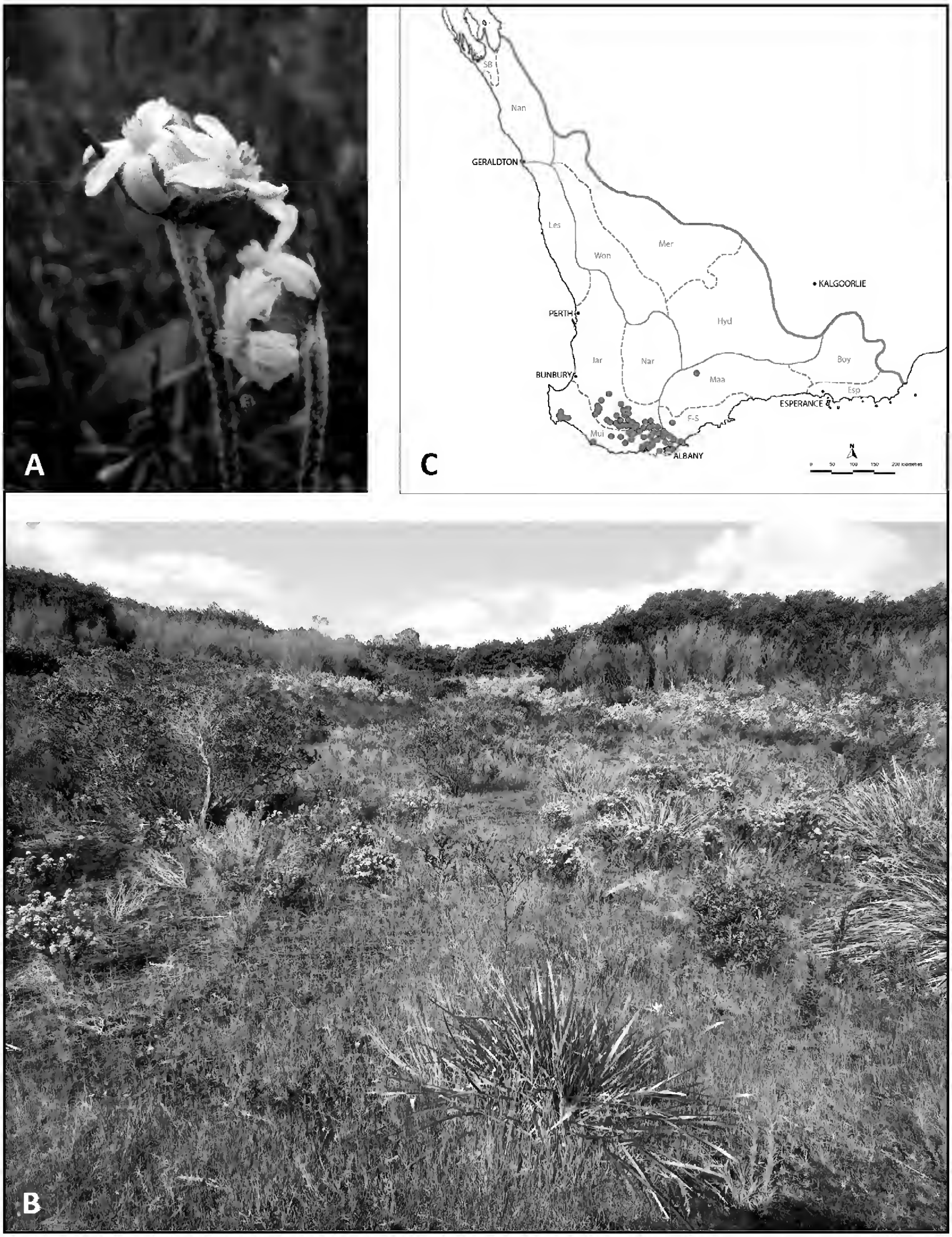

Figure 9. *Tribonanthes australis*. A – plants showing multi-flowered inflorescences (*E.J. Hickman* 2067); B – habitat (*E.J. Hickman* 2067), shrubland of *Taxandria marginata* and *Verticordia plumosa* associated with herbfield of *Stypandra glauca* and *Drosera menzesii* over granite on south-west slopes of Mt Melville, Albany, Western Australia; C – distribution in south-western Australia with *SWAFR* provinces and districts shown in grey (Kalbarri Province: SB – Shark Bay District, Nan – Nanda District; Bibbulmun Province: Les – Lesueur District, Jar – Jarrah District, Nar – Narrogin District, Mui – Muir District; Southeast Coastal Province: Maa – Maalak District, F-S – Fitzgerald-Stirling District, Boy – Boylya District, Esp – Esperance District; Transitional Rainfall Province: Won – Wongan District, Mer – Merredin District, Hyd – Hyden District (Gioia & Hopper 2017). Photos by E.J. Hickman.

Woodland vegetation association, of the Albany Regional Vegetation Survey (Sandiford & Barrett 2010).

2. Tribonanthes uniflora Lindl., *Sketch Veg. Swan R.* xliv (1840).

Type: Swan River, Western Australia, *J. Mangles s.n.* (*lectotype*: CGE 06825! *fide* T.D. Macfarlane, *Fl. Australia* 45: 465 (1987)).

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); J.R. Wheeler in J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* Vol. 1: 314 (2002).

Herb annually renewed from a white ovoid corm, small to medium plant, 6.5–21.4 cm tall above ground, consisting of a single stem and single leaf. *Corms* 4–8 mm diameter, covered by numerous old brown, papery sheaths, 1.2–5.3 cm below soil surface. *Roots* white, no root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 1.5–15 cm, glabrous. *Basal leaf* 4–16.5 cm long, erect, stem-clasping to terete, red-purple base grading to green apically, with mucronate tip, glabrous. *Inflorescence bract* 1.4–6.4 cm long, erect, funnel-like sheath with broad dilated mouth, 4–8 mm circumference at widest point, red-purple, broad membranous margin tinged red and fringed with white trichomes, lamina 5–35 mm long, terete, green, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 0.4–7.7 cm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by one or two floral bracts. *Floral bract* obovate, 7–13 mm long, 3–8 mm wide, green with purple margin fringed with white trichomes and scattered trichomes on the base, with a short terete mucronate apex, 1–5 mm long, ending in a darker tip, exceeding perianth lobes. *Perianth lobes* 5–9.4 mm long, 1.5–3.2 mm wide, spreading, obovate, with white hairy inner and outer lobe surfaces, dark mucronate tips. *Perianth tube* 2.8–7.4 mm long, outer surface covered in long white woolly trichomes forming a distinctly fluffy skirt, inner surface white, glabrous. *Stamen connective appendages* 0.5–4 mm long, 1.2 mm wide, creamy white topped with 3 finger-like projections with rounded tips, equal to slightly exceeding anther tips. *Anthers* 1.5–3.4 mm long, yellow, with cream sterile apex that projects towards centre of flower, attached centrally on stamen connective appendages. *Ovary* green, half-inferior, locules 3 with several (15) ovules per locule. *Style* 0.7–2.5 mm long, green. *Stigma* simple, capitate, yellow, glandular, glabrous. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, spreading to reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 10, 11)

Diagnostic features. Small to medium plant, terete leaf, long woolly peduncles, solitary flowered inflorescence, woolly white flowers, obvious cream stamen connective appendages, medium style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Guildford, Sep. 1901, *C.Andrews s.n.* (PERTH); Coomalbidgup, 4 Aug. 1965, *J. Bowen s.n.* (PERTH); Wandoo Conservation Park, Goonapping Swamp, 17 Sep. 2014, *K.L. Brown & G. Paczkowska* KLB 1153 (PERTH); N side of Lake Powell, W of Albany, 25 Sep. 1983, *D. Davidson s.n.* (PERTH); Cowalellup Rd, 1.2 km W of intersection with Boxwood Hill–Ongerup Rd, S side of road, 29 Oct. 2013, *E.J. Hickman* 2010 (PERTH); McNeil Rd, 2.6 km E of Kellerberrin–Yoting Rd, 100 m S of road side, 12 Sep. 2014, *E.J. Hickman* 2049 (PERTH); Moses Rock, 150 m S of T-junction at end of Moses Rock Rd, 50 m W to granite rock, 20 Sep. 2014, *E.J. Hickman* 2055 (PERTH); Mettabinup Nature Reserve, 3.3 km W along Flora and Fauna Rd from Tone Rd, then 500 m W into reserve to SW boundary, 20 Sep. 2014, *E.J. Hickman* 2061 (PERTH); Jingalup Nature Reserve, 1.1 km W of Kojonup–Frankland Rd on Settlers Rd, S side

of road in claypan, 20 Sep. 2014, *E.J. Hickman* 2062 (PERTH); Break Rd, 2.6 km W of turn-off to Mt Lindesay, N side of road, 3 Nov. 2014, *E.J. Hickman* 2071 (PERTH); Moses Rock, 150 m S of T-junction at end of Moses Rock Rd, 50 m W to granite rock, 16 Aug. 2016, *E.J. Hickman* 2084 (PERTH); 8 km S of Eneabba, 27 Sep. 1977, *R. Hnatiuk* 771396 (PERTH); Kemerton, 2 Sep. 2003, *G.J & B.J. Keighery* 261 (PERTH); Pinjarra Nature Reserve, 30 Aug. 2007, *G.J. Keighery* 17134 (PERTH); 17.2 km W of Northampton on Port Gregory Rd, 25 July 2009, *G.J. & B.J. Keighery* 1569 (PERTH); Warrenup Nature Reserve, W of Kendenup, 19 Sep. 2009, *G.J. Keighery* 17561 (PERTH); Plain Rd, NW of Walpole, 21 Sep. 1983, *R.Ornduff* 9329 (PERTH); Mt Chudalup, 5 Sep. 1985, *J.R. Wheeler* 2389 (PERTH).

Proposed vernacular name. Woolly Tiurndin.

Phenology. Flowers from August to October.

Distribution and habitat. *Tribonanthes uniflora* is known from scattered populations both coastal and inland, from north of Geraldton to west of Esperance. Most collections are from the Jarrah, Muir and Lesueur Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), but there are collections from the Nanda District of the Kalbarri Province, Wongan District of the Transitional Rainfall Province and Maalak District of the Southeast Coastal Province. It grows on seasonally wet brown to grey sandy clays in moss swards and shallow soil pockets of granite sheets and outcrops or on winter wet flats associated with *Melaleuca* shrublands, open woodlands and forest fringes around granite. Associated species include *Eucalyptus occidentalis*, *E. rudis*, *Melaleuca preissiana*, *M. hamulosa*, *M. lateritia*, *M. uncinata*, *M. viminea*, *Hakea prostrata*, *H. varia*, *Verticordia plumosa*, *Dodonaea ceratocarpa*, *Xanthorrhoea preissii* and a variety of herbs and sedges (Figure 11).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin *unus* (one) and *florus* (flowered), referring to the single-flowered inflorescence of this species.

Notes. *Tribonanthes uniflora* collections have previously been identified as *T. australis*, *T. longipetala* or *T. violacea*. *Tribonanthes uniflora* differs from *T. australis* in having a smaller habit and a smaller, single-flowered inflorescence. It differs from *T. longipetala* in having terete leaves and shorter perianth lobes and obvious cream stamen connective appendages, rather than bright yellow stamen connective appendages. It differs from *T. violacea* in having an obvious peduncle, which is covered in woolly trichomes from the inflorescence bract to the first floral bract. This species is similar to *T. monantha* in its small stature and single-flowered habit but differs in having an inflorescence bract with a narrower transparent margin fringed with white simple trichomes. Also the flowers of *T. monantha* tend to turn purple at senescence while *T. uniflora* flowers remain white.

3. Tribonanthes longipetala Lindl., *Sketch Veg. Swan R.* xliv (1840).

Type: Swan River [Colony], Western Australia, 1839, *J. Drummond s.n.* (*lecto* here chosen: CGE 06824! left specimen; *isolecto*: K 000846201 image!); Swan River, Western Australia, *J. Mangles s.n.* (*syn*: CGE 06824! right specimen).

Tribonanthes lindleyana Endl. in Lehm., *Pl. Preiss.* 2: 27 (1846), *nom. illeg.*, *nom. superfl.* *Type*: Swan River [Colony], Western Australia, 1839, *J.A.L. Preiss* 1561 (*holo*: LD 1811505 image!; *iso*: MEL 104294 image!, P 01698194 image!, S 06-11224 *n.v.*).

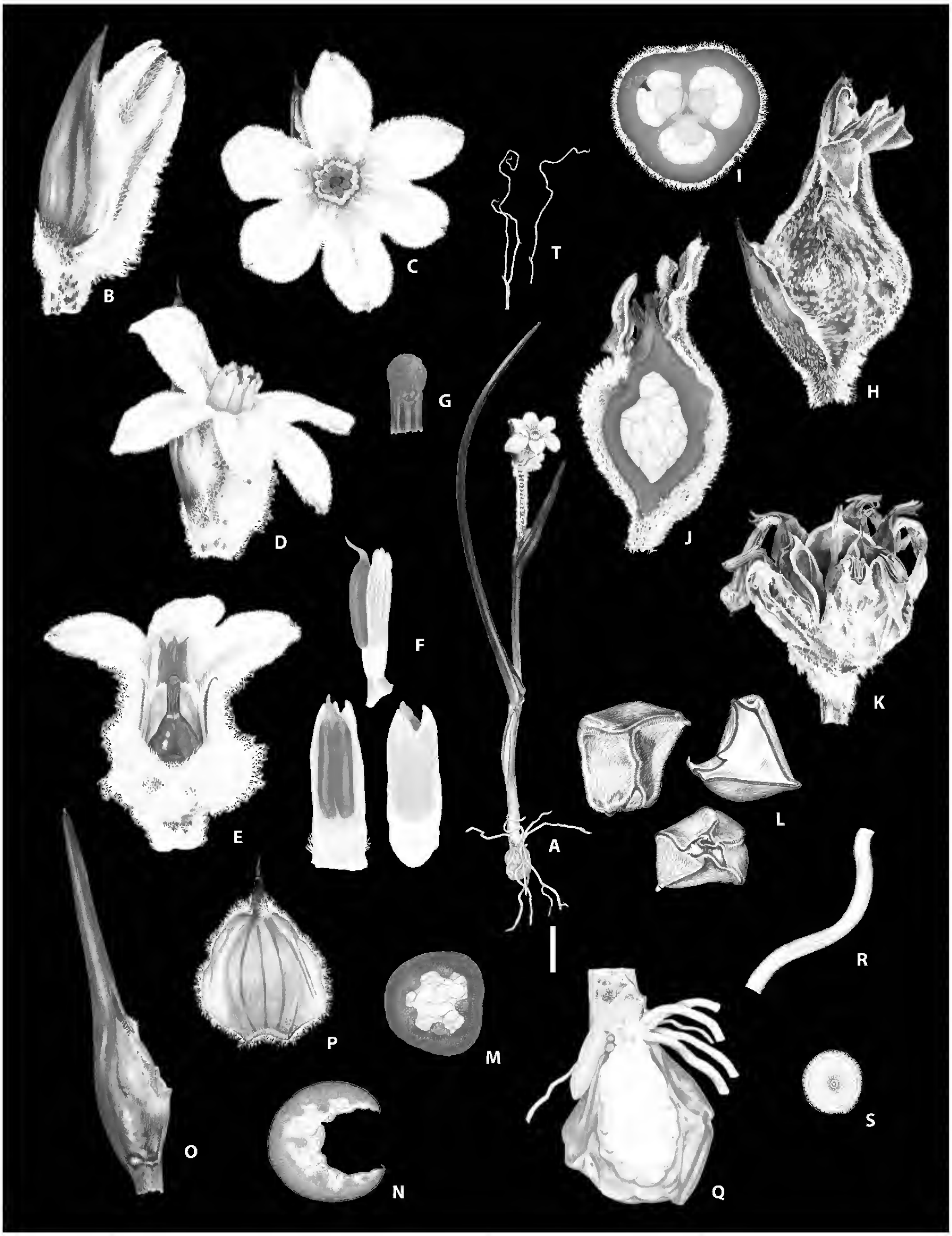

Figure 10. *Tribonanthes uniflora*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing stamen connective appendages small, just shorter than anthers and yellow anthers with apex apiculate and projecting forwards; G – style slightly elongated with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root (scale bar = 0.5 mm); T – detail of perianth trichomes (scale bar = 0.65 mm). Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, O, P, Q, R); 1 mm (F, G, M, N); 2 mm (H, I, J, K); 0.5 mm (L, S); 0.65 mm (T). Drawn from fresh material from *E.J. Hickman* 2084 (PERTH 08988579). Illustrations by E.J. Hickman.

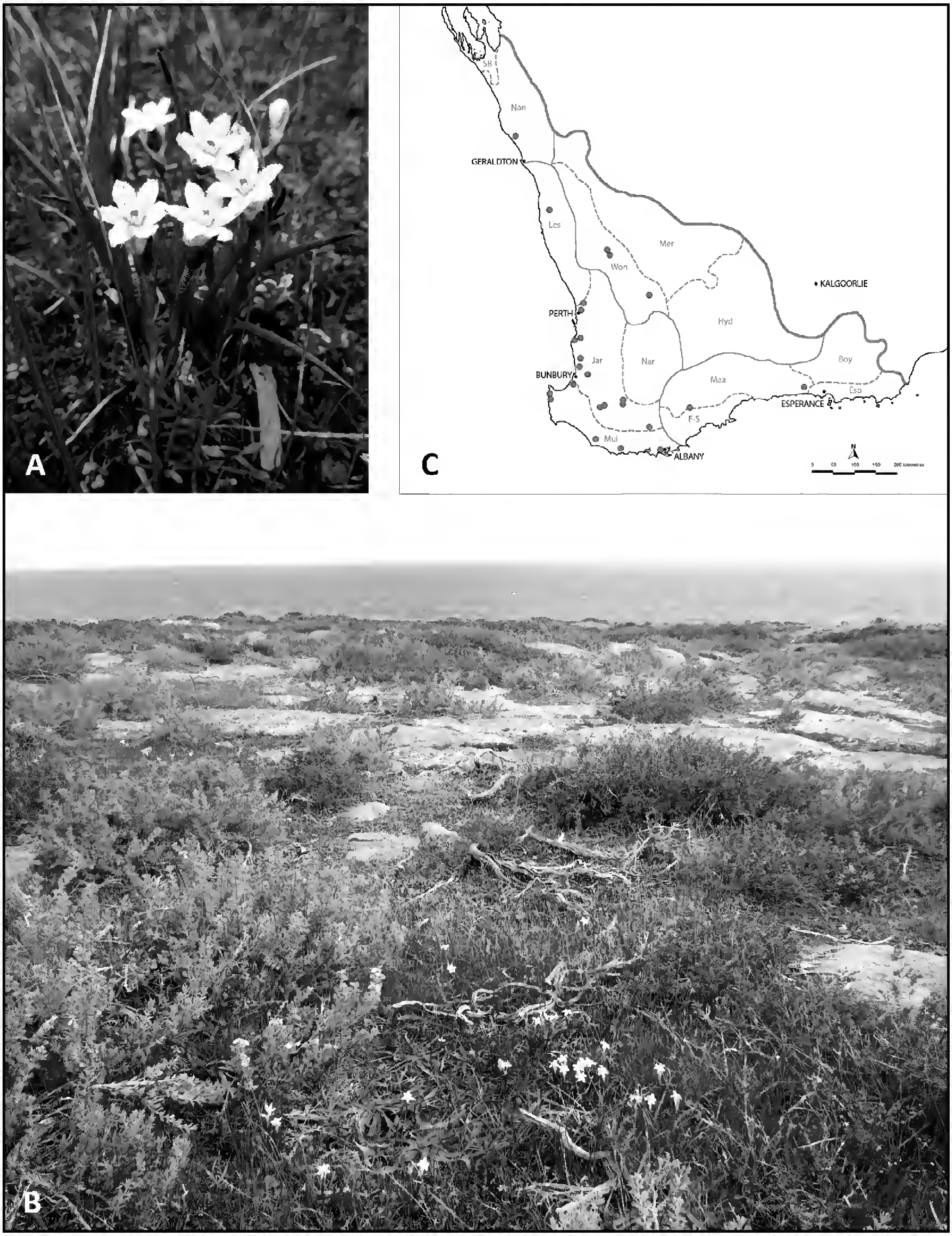

Figure 11. *Tribonanthes uniflora*. A – group of plants each with a solitary-flowered inflorescence, (*E.J. Hickman* 2084); B – habitat (*E.J. Hickman* 2084), granite pavement with wind pruned shrubs *Dodonaea ceratocarpa, Verticordia plumosa var. plumosa* and *Leucopogon parviflorus* over herbs, sedges and grasses at Moses Rock, south of Yallinup, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); T.D. Macfarlane *in* N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane, *Fl. Perth Region* p. 859, Figure 310 (1987); T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 A–E (1987); J.R. Wheeler *in* J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* Vol. 1: 313 (2002).

Herb annually renewed from a white ovoid corm, 7.3–40 cm tall, consisting of a single branched aerial stem and single leaf. *Roots* white, with visible white root trichomes, that sometimes have an associated loose sand-binding rhizosheath. *Corms* 12.5–15 mm diameter, covered by numerous old brown, papery sheaths, 2–10 cm below soil surface. *Aerial stem* (from basal leaf to inflorescence bract) 2–13.3 cm, lower 1/2 glabrous, the remainder with scattered trichomes. *Basal leaf* 4.5–23 cm long, erect, sheath stem-clasping, lamina flattened, green, with dark mucronate tip, glabrous. *Inflorescence bract* 2.5–13 cm long, erect, stem-clasping below, 6–10 mm circumference at widest point, green with noticeable longitudinal veins and thin scarious margins; lamina 2–100 mm long, flattened, green with darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to lowest branching point) 3.3–28 cm long, covered in white woolly trichomes, sparser on lower 1/2. *Inflorescence* a loose cyme of 2–5 pedicellate flowers, each subtended by a single floral bract. *Pedicels* 30–60 mm long, covered in white woolly trichomes. *Floral bract* 11–22 mm long, 2–5 mm wide, lanceolate, green with prominent longitudinal veins, outside surface hairy at base, inside surface glabrous, margins membranous, hairy, apex shortly terete, 0.5–5 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 10–16 mm long, 2–4 mm wide, spreading to recurved, linear to narrowly obovate, inner and outer surfaces white woolly hairy, with purple tinge along midline of outer surface, apex with a dark mucronate tip. *Perianth tube* 4–7 mm long, outer surface covered in silky white trichomes, with longer silky trichomes at base forming a distinct skirt, inner surface pale green, glabrous. *Stamen connective appendages* small, 2.0–3.0 mm long, 1.1–1.2 mm wide, yellow, topped with 5–7 short rounded tips, their apices below anther tips. *Anthers* 3–4 mm long, yellow, with deep yellow sterile apex that projects upwards, attached centrally on stamen connective appendage. *Ovary* green, inferior, locules 3 with few (9) ovules per locule. *Style* short to sub-sessile, 0.7–2 mm long, green and purple longitudinal striations. *Stigma* capitate, green, with prominent tuft of white silky trichomes on top. *Capsule* greyish brown; perianth persistent; lobes spreading before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 12, 13)

Diagnostic features. Tall plant, flattened leaves, long peduncles, multi-flowered inflorescence with long pedicels, woolly white flowers with long narrow perianth lobes, small yellow stamen connective appendages, short to sub-sessile style, stigma with prominent tuft of silky white trichomes on top, inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: 4.8 km NW of Mount Yetar, 5 Nov. 1996, *M.G. Allen* 136 (PERTH); Ellis Brook Valley Reserve, 25 Aug. 1999, *H. Bowler* 411 (PERTH); Waroona, 29 Oct. 1997, *R.J. Cranfield* 11428 (PERTH); Lower Chittering, 26 July 1959, *A.S. George* 35 (PERTH); Baker's Hill Research Station, 26 Sep. 1962, *D.W. Goodall* 756 (PERTH); Talbot Rd Nature Reserve, 350 m W along central track from Talbot Rd, S side of track, 27 Aug. 2014, *E.J. Hickman* 2020 (PERTH); Gooseberry Hill, 170 m E of Watsonia Rd, and 210 m N of Gooseberry Hill Rd, 27 Aug. 2014, *E.J. Hickman* 2021 (PERTH); Wannamal Townsite, 7 Aug. 1997, *R. Hindmarsh* 19 (PERTH); Bodhinyana Monastery, Serpentine, 24 Aug. 2002, *B. Nyanatusita* 123 (PERTH); Qualen Rd, SW of York, 18 Sep. 1984, *S. Patrick* 148 (PERTH); 9 km SE of Bolton Pools, 13 Aug. 1997, *G. Paull* 1705 (PERTH).

Proposed vernacular name. Branching Tiurndin.

Phenology. Flowers from July to November.

Distribution and habitat. *Tribonanthes longipetala* has been collected from populations along the Darling Scarp, from Wannamal north of Perth to Waroona and east to Baker's Hill. Most collections are along the border between the Lesueur and Jarrah Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017). It grows on seasonally wet brown clay loam or sandy clays associated with granite or laterite on slopes or flats that are winter wet and associated with open woodlands, shrublands and herbfields. Associated species include *Corymbia calophylla*, *Eucalyptus wandoo*, *Acacia pulchella*, *Hakea lissocarpha*, *Xanthorrhoea preissii* and a variety of herbs and sedges (Figure 13).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin *longus* (long) and *petalum* (petal), referring to the long narrow perianth lobes of this species.

Notes. Based on determinations on herbarium specimens, Macfarlane (1987) did not distinguish our *T. elongata* from *T. longipetala*. However, *T. longipetala* differs from *T. elongata* in having flattened leaves, a taller stature and pedicellate flowers in a multi-flowered inflorescence. *Tribonanthes longipetala* is generally found in seasonally wet areas on the slopes of the Darling Scarp, while *T. elongata* is more widespread in winter wet areas throughout the SWAFR. The other significant difference between these two species is that *T. elongata* has fine transparent trichomes on the inside of the stamen connective appendage below the anther, while *T. longipetala* has glabrous stamen connective appendages. On the specimen sheet CGE 06824 the left-hand specimen of *T. longipetala* is designated the lectotype of the species, as indicated on a determinavit slip by A.S. George 15 August 1968. T.D. Macfarlane examined the specimen in 1984, noted that George's lectotypification was never published, but evidently chose not to lectotypify the species. We lectotypify the species here to put typification beyond doubt, in view of the frequency of mixed taxa in collections of this genus.

4. Tribonanthes monantha E.J.Hickman & Hopper, *sp. nov.*

Type: Chingah Hill, east of the intersection of Allsop Road and Depot–Dam Road, 30 km south of Merredin via Merredin–Narembeen Road, Western Australia, 12 September 2014, *E.J. Hickman* 2048 (*holo:* PERTH 08986991; *iso:* CANB).

Illustrations: nil other than those herein.

Herb annually renewed from a white ovoid corm, 5–21 cm tall, consisting of a single stem and single leaf. *Corms* 6.0–6.9 mm diameter, covered by numerous old brown, papery sheaths, 2.3–5.2 cm below surface. *Roots* white, with long white root trichomes, no sand-binding rhizosheath. *Aerial stem* (between basal leaf and inflorescence bract) 1–18.5 cm, glabrous. *Basal leaf* 3.2–15.6 cm long, spreading or erect, stem-clasping at base, red-purple, becoming terete, green, with mucronate tip, glabrous. *Inflorescence bract* 9–50 mm long, erect, funnel-like sheath with broad dilated mouth, 4–9 mm circumference at widest point, purple tending to green with three darker longitudinal stripes, puncticulate, glabrous surface, membranous margins, no fringing trichomes, terete at top for 1–30 mm, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 2–56 mm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 6–12 mm long, 3.5–7 mm wide, ovate, green-purple, broad membranous margins, fringed with

Figure 12. *Tribonanthes longipetala*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing yellow stamen connective appendages shorter than anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of silky white trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes (scale bar = 0.4 mm). Scale bars = 1 cm (A, O); 4 mm (B, C, D, H); 2.5 mm (E, N, P); 1 mm (F, G, N, L); 2 mm (I, J, K, M, R); 0.5 mm (L, S); 5 mm (Q); 0.4 mm (T). Drawn from fresh material *E.J. Hickman* 2021 (PERTH 08989400). Illustrations by E.J. Hickman.

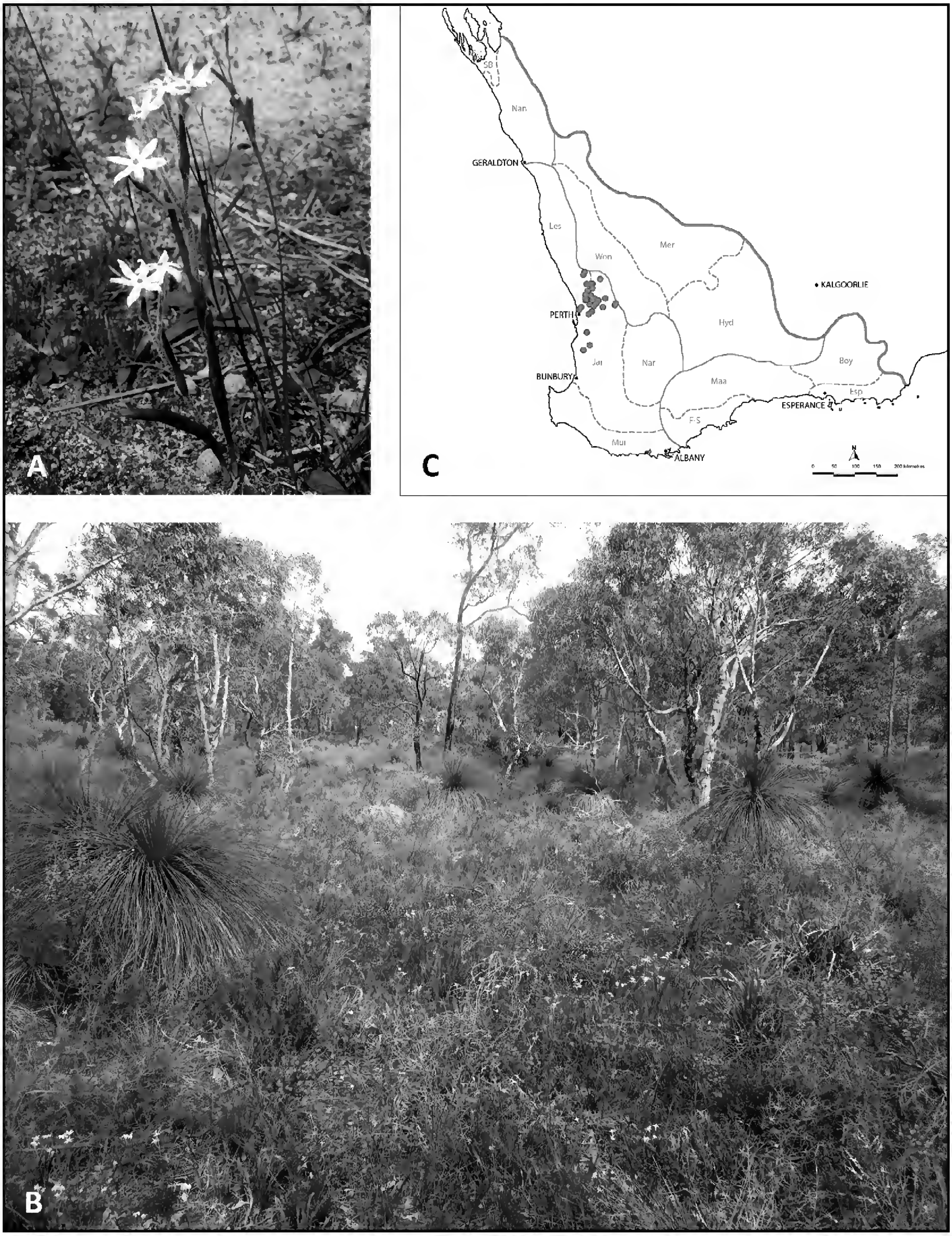

Figure 13. *Tribonanthes longipetala*. A – group of plants each with a multi-flowered inflorescence, (*E.J. Hickman* 2020); B – habitat (*E.J. Hickman* 2021), open *Eucalyptus wandoo* woodland with understorey shrubs *Acacia pulchella, Hakea lissocarpha, Hypocalymma angustifolium* and *Xanthorrhoea preissii* over herbs, sedges and grasses in remnant vegetation on the corner of Watsonia Road and Gooseberry Hill Road, Gooseberry Hill, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photo by E.J. Hickman.

fine white trichomes, otherwise glabrous inside and out, apex shortly terete, 0.5–3 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 3–8 mm long, 2–4 mm wide, spreading, dilated, white woolly hairy inside and outside, tinged pale purple when senescing, dark mucronate tips. *Perianth tube* 3–6 mm long, outer surface covered in white woolly trichomes, inner surface green and glabrous. *Stamen connective appendages* relatively large, 1.5–3 mm long, 1.3–1.5 mm wide, creamy white, topped with 4 or 5, round-tipped finger-like projections, extending above anther tips. *Anthers* 1.9–2.5 mm long, yellow, with yellow sterile apex that projects towards centre of flower, attached at base of stamen connective appendage. *Ovary* green, half-inferior, locules 3 with numerous (25) ovules per locule. *Style* short to sub-sessile, 0.4–2 mm long, green with longitudinal purple stripes. *Stigma* capitate, yellow, glandular. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 14, 15)

Diagnostic features. Medium plant, terete leaves, long peduncles, solitary flowered inflorescence, woolly white flowers turning purple at senescence, obvious cream stamen connective appendages, short to almost absent style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: granite slab, South West Highway, 8.6 km S of Weld Rd, 16 Sep. 1994, *A.R. Annels & R.W. Hearn* ARA 4440 (PERTH); Gull Rock Lake, Albany, 30 Sep. 1984, *R.J. Cranfield* 4970 (PERTH); 1.5 km W of SW boundary of Chiddarcooping Nature Reserve, 11 Sep. 1989, *R.J. Cranfield* 7803 (PERTH); Bunny Rd W of Three Springs, 3 Oct. 1990, *R.J. Cranfield & P.J. Spencer* 7953 (PERTH); Grevillea Rock, 12 Aug. 2003, *R.J. Cranfield* 19414 (PERTH); Hillman townsite, NE of Darkan, 15 Sep. 1994, *V. Crowley* DKN 69 (PERTH); Water Reserve Capitella Rd, SE of Dandaragan, 10 Sep. 1988, *E.A. Griffin* 5000 (PERTH); Brixton Street Wetlands, Kenwick, 27 Aug. 2014, *E.J. Hickman* 2024 (PERTH); Munbinea Rd, 10 km south of Bibby Rd, 28 Aug. 2014, *E.J. Hickman* 2027 (PERTH); Old Muntadgin Rd, 3.5 km north of intersection with Briant Rd, 12 Sep. 2014, *E.J. Hickman* 2047 (PERTH); Yelverton State Forest, 2 Oct. 1986, *S.D. Hopper* 5596 (PERTH); Jeegarnyeejip Island, Murray River Delta, 16 Nov. 2000, *G.J. Keighery* 16156 (PERTH); Nullilla Nature Reserve S of Gingin, 14 Sep. 2005, *G.J. Keighery* 16581 (PERTH); Petrudor Rock Reserve, SE of Dalwallinu, Aug. 1984, *N.G. Marchant s.n.* (PERTH); Wongan Hills, 10 Sep. 1962, *F.W. Went* 160 (PERTH).

Proposed vernacular name. Widespread Tiurndin.

Phenology. Flowers from August to September.

Distribution and habitat. *Tribonanthes monantha* is known from scattered locations along the coast and inland from Arrowsmith in the north to Albany in the south and to Chiddarcooping Nature Reserve, north-east of Merredin. Populations are located within the Lesueur, Jarrah and Muir Districts of the Bibbulmun Province and Wongan, Merredin and Hyden Districts of the Transitional Rainfall Province of south-west Western Australia (Gioia & Hopper 2017). *Tribonanthes monantha* grows on a variety of soil types from sandy clays to loams as well as peat, associated with granite and laterite. These areas are winter wet depressions, flats, drainage-lines or swamps supporting shrublands, herbfields or samphire with associated species including *Acacia acuminata*, *Casuarina obesa*, *Melaleuca viminea*, *M. uncinata*, *M. lateriflora*, *Tecticornia indica* and *T. halocnemoides* (Figure 15).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Greek *monos* (alone or solitary) and *anthos* (flower), referring to the single flower of this species.

Notes. *Tribonanthes monantha* collections have previously been identified as belonging to *T. australis*, *T. longipetala* and *T. violacea*. *Tribonanthes monantha* resembles *T. australis* in having horizontally spreading perianth lobes covered on both sides in white woolly trichomes and having a conspicuous corona-like structure of creamy white stamen connective appendages exceeding the anther tips. However, *T. monantha* differs from *T. australis* in having a smaller habit and smaller single-flowered inflorescence, with inflorescence bracts having distinct broad membranous glabrous margins instead of hairy margins. The perianth lobes of *T. monantha* are broader relative to their length than those of *T. australis*. *Tribonanthes monantha* differs from *T. longipetala* in having shorter perianth lobes and cream (not bright yellow) stamen connective appendages. *Tribonanthes monantha* differs from *T. violacea* in having an obvious peduncle, which is covered in woolly trichomes from the inflorescence bract to the first floral bract. *Tribonanthes monantha* is distinctly different to *T. minor* in having spreading rather than strongly reflexed perianth lobes and having creamy-white rather than yellow staminal appendages. *Tribonanthes monantha* is similar to *T. uniflora* in its small to medium stature and single-flowered habit but differs in having an inflorescence bract with a broader membranous margin and no fringing hairs and the flowers of *T. monantha* turn purple at senescence while *T. uniflora* flowers remain white.

5. Tribonanthes porphyrea E.J.Hickman & Hopper, *sp. nov.*

Type: Bashford Nature Reserve, south-east corner of reserve in claypan, off Bootoo Road, east of Indian Ocean Drive, Western Australia, 28 August 2014, *E.J. Hickman* 2025 (*holo*: PERTH 08986959, *iso*: CANB).

Illustrations. Nil other than those herein.

Herb annually renewed from a white ovoid corm, 10.4–30.5 cm tall above ground, consisting of a single stem and single leaf. *Corms* 3.8–6.2 mm diameter, covered by numerous old brown, papery sheaths, 2–7.7 cm below soil surface. *Roots* white, with white rootlets, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 6.5–27 cm, glabrous. *Basal leaf* 8.8–20 cm long, attached to aerial stem 0–7.5 cm above ground, erect, sheath stem-clasping, green, lamina filiform to sub-terete, glabrous. *Inflorescence bract* 1–7.1 cm long, erect, funnel-like sheath with broad dilated mouth, 4–8 mm circumference at widest point, green, the membranous margin tinged purple and fringed with fine white trichomes; lamina 4–90 mm long, terete, green, glabrous, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 0.1–11 cm long, sparsely hairy. *Inflorescence* a solitary flower, subtended by one or two floral bracts. *Floral bract* 8–19 mm long, 4–8 mm wide, oval, green with membranous margin fringed with white trichomes and scattered trichomes on the base, apex 1–9 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 6.4–15 mm long, 2.1–5 mm wide, spreading, inner surface white velvety hairy, outer surface deep purple sparsely hairy. *Perianth tube* 3.3–7.1 mm long, pale green to white, inner surface glabrous, outer surface woolly hairy. *Stamen connective appendages* 2–4 mm long, 1.5–2.1 mm wide, cream, tips rounded with some small scattered purple spots, exceeding anther tips. *Anthers* 2.5–4 mm long, yellow, with elongated cream sterile apex that projects upwards, attached centrally on stamen connective appendages. *Ovary* green, half-inferior, locules 3 with many (78) ovules per locule. *Style* 0.7–2 mm long, green. *Stigma* capitate, yellow, with elongated tip covered in short trichomes and three glandular protuberances on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 16, 17)

Diagnostic features. Tall plant, filiform to sub-terete leaf often sub-basal, short peduncles, solitary flowered inflorescence, velvety white flowers with deep purple outer surface and broad perianth lobes,

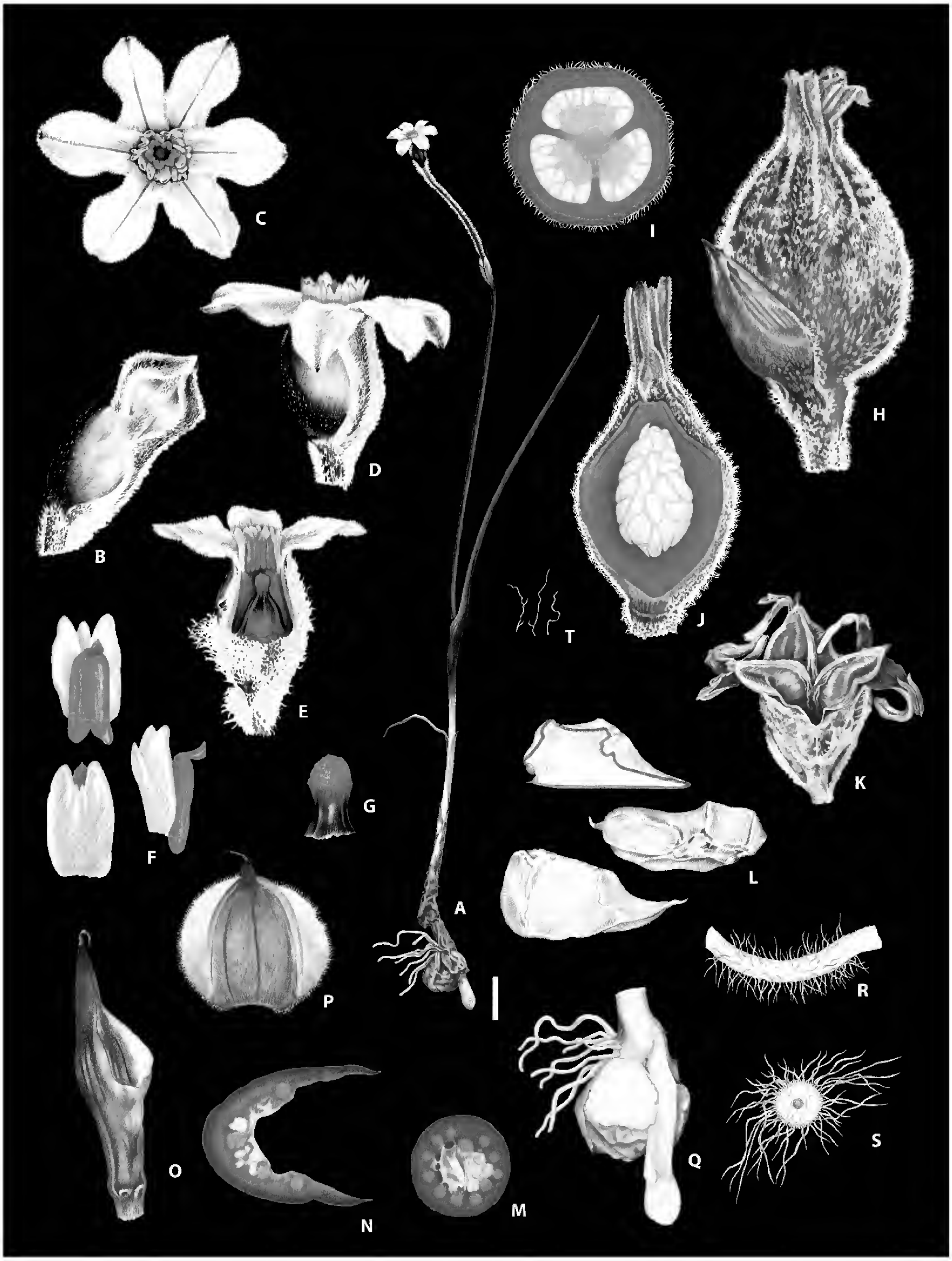

Figure 14. *Tribonanthes monantha*. A – whole plant; B – bud; C – flower from top showing short broad perianth lobes; D – flower from side showing floral bract with broad scarious margin and coronet of filament appendages; E – flower with part of perianth removed to show ovary and style; F – anthers from front, back and side view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting forwards; G – style sub-sessile with simple stigma; H – capsule; I – cross section through capsule); J – longitudinal section through capsule; K – dehisced capsule; L – seed; M – leaf cross section near apex; N – leaf cross section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2 mm (B, C, D, E, H, I, J, K, O, P); 0.8 mm (F, G); 1 mm (L); 0.65 mm (M, N); 4 mm (Q); 1.25 mm (R); 0.5 mm (S, T). Drawn from fresh material *E.J. Hickman* 2048 (PERTH 08986991). Illustrations by E.J. Hickman.

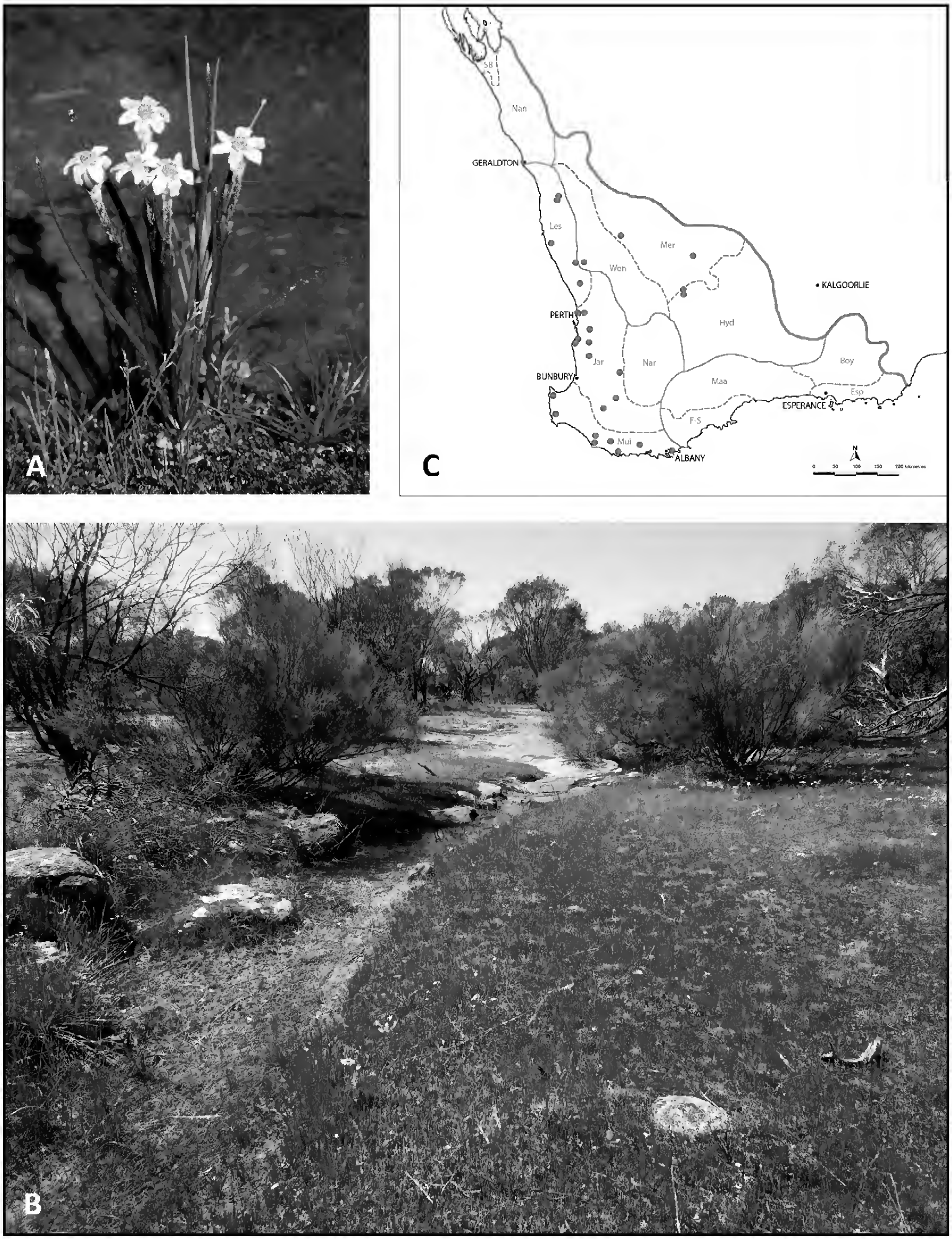

Figure 15. *Tribonanthes monantha*. A – group of plants each with a single-flowered inflorescence with cream stamen connective appendages and spreading perianth lobes covered in woolly white trichomes, (*E.J. Hickman* 2048); B – habitat (*E.J. Hickman* 2048), herbfield and fringing shrubland along a drainage-line at the base of Chingah Hill, a granite hill south-east of Merredin, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

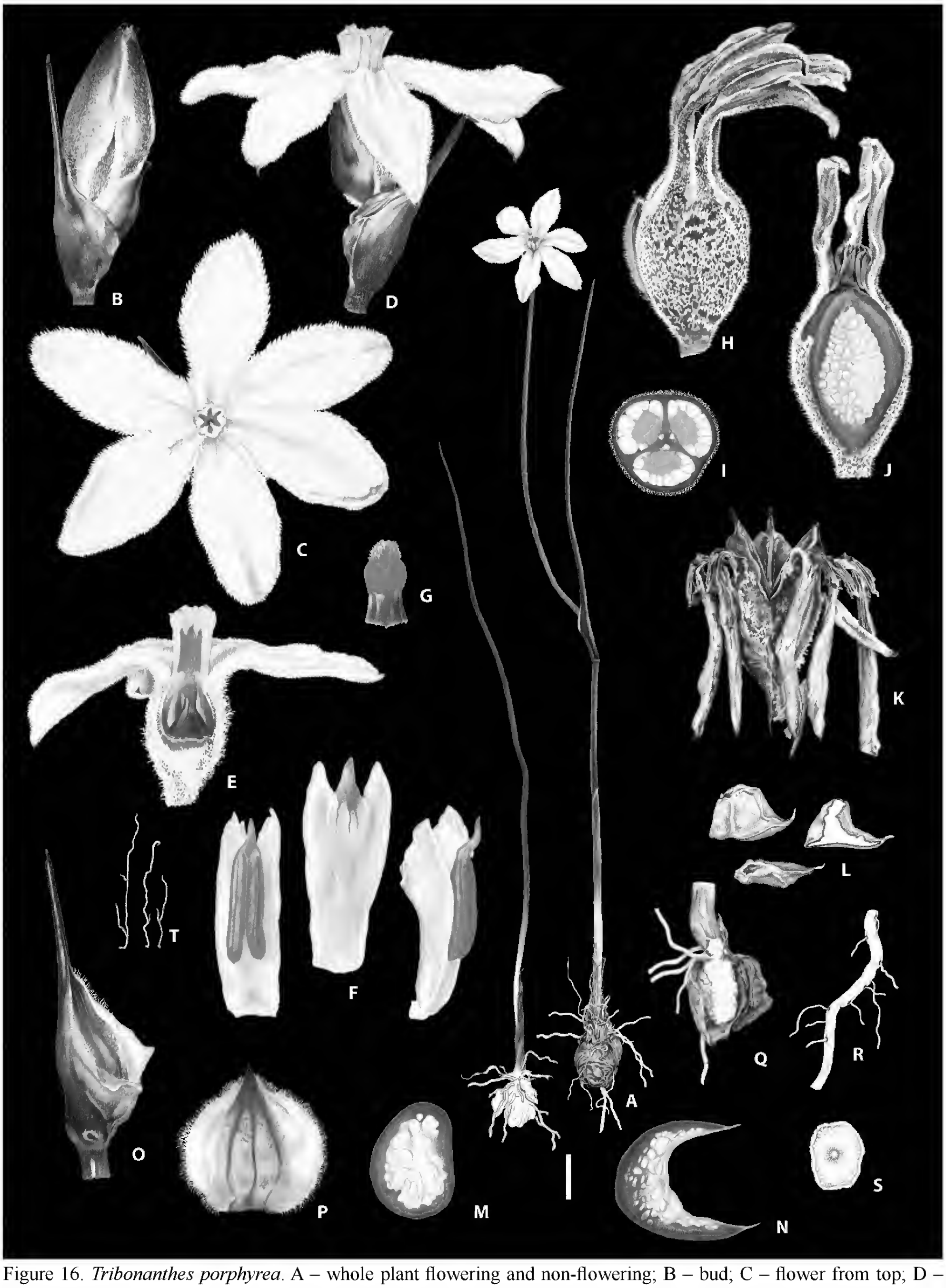

Figure 16. *Tribonanthes porphyrea*. A – whole plant flowering and non-flowering; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, back and side view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, H, I, J, K, O, P, R); 1 mm (F, G); 0.5 mm (L); 0.65 mm (M, N, T); 4 mm (Q); 0.4 mm (S). Drawn from fresh material *E.J. Hickman* 2025 (PERTH 08986959). Illustrations by E.J. Hickman.

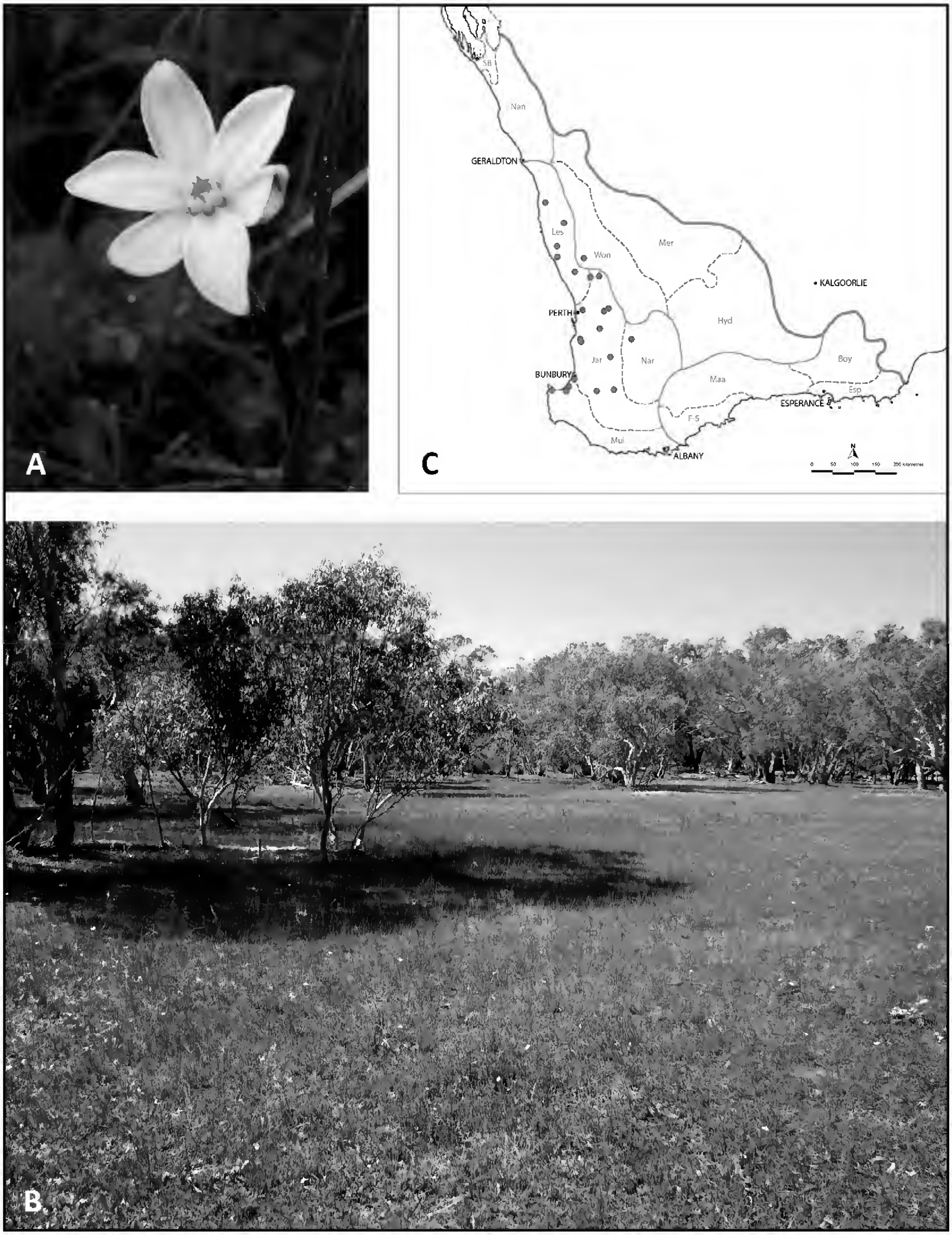

Figure 17. *Tribonanthes porphyrea*. A – single-flowered inflorescence with cream stamen connective appendages and spreading perianth lobes covered in silky white trichomes on inner surface and sparsely hairy on outer surface (*E.J. Hickman* 2025); B – habitat (*E.J. Hickman* 2025), water-logged herbfield in a winter wet depression, fringed by *Eucalyptus rudis* woodland, Bashfords Nature Reserve, north-east of Lancelin, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

obvious cream stamen connective appendages, short style, stigma with tuft of short trichomes and three glandular protuberances, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Lake Wannamal Nature Reserve, 1 km E of Bindoon–Moora Rd, 9 Sep. 2014, *K.L. Brown* 1149 (PERTH); Julimar State Forest, 2 km S of Bindoon–Dewars Pool Rd, 10 Sep. 2014, *K.L. Brown et al.* KLB 1151 (PERTH); Drummond Nature Reserve, 10 Sep. 2014, *K.L. Brown et al.* KLB 1152 (PERTH); Little Darkin Swamp, Wandoo National Park, 26 Nov. 2005, *A. Crawford* ADC 991 (PERTH); Cell 10, Hartwood Rd, NW of Boyup Brook, 28 Oct. 1998, *R. Davis* 8086 (PERTH); Pinjarra Nature Reserve, 6 Aug. 2007, *P. Foreman & J. Kelly* PJ 510 (PERTH); Drummond Nature Reserve, 12 Oct. 1998, *N. Gibson* 4317 (PERTH); Popanyinning, 22 Sep. 1996, *A.G. Gunness et al.* POPO 19/29 (PERTH); Leda Nature Reserve, 3.3 km S of Beekeepers Rd, 5.8 km W of Brand Hwy, 20 Aug. 2014, *E.J. Hickman* 2013 (PERTH); Brixton Street Wetlands, Alton St, walktrail into claypan, 4 Sep. 2014, *E.J. Hickman* 2045 (PERTH); Ambergate Regional Park, S of Busselton, SW of intersection of Doyle Rd and Queen Elizabeth Ave, 16 Aug. 2016, *E.J. Hickman* 2088 (PERTH); 5 km E of Quindanning to Williams, 26 Sep. 1987, *G.J. Keighery* 9166 (PERTH); Simmonds Block, Tuart Forest 15 Sep. 1994, *G.J. Keighery* 15005 (PERTH); Gillingarra Nature Reserve, 18 Sep. 2008, *G.J. Keighery* 17327 (PERTH); Lower Canning River, 28 Sep. 1898, *A. Morrison* 8276 (PERTH); Meelup Reserve, Dunsborough, 5 Sep. 2006, *R. Watkins* BNC 1014 (PERTH).

Proposed vernacular name. Purple-budded Tiurndin.

Phenology. Flowers from August to November.

Distribution and habitat. *Tribonanthes porphyrea* is known from scattered locations along the coast and inland from Eneabba in the north to Boyup Brook in the south and east to Popanyinning. Populations are located within the Lesueur, Jarrah, Muir and Narrogin Districts of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), with a single population known from the western edge of the Wongan District of the Transitional Rainfall Province (PERTH 08504083). *Tribonanthes porphyrea* grows on brown to grey clays and sandy clays as well as peat, in standing water of winter wet depressions, flats, claypans and swamps, supporting open woodland, shrublands, herbfields or sedgeland with associated species including *Eucalyptus rudis*, *E. wandoo*, *Corymbia calophylla*, *Melaleuca viminea*, *M. lateritia*, *M. uncinata*, *M. rhaphiophylla*, *Viminaria juncea*, *Acacia acuminata*, *Astartea affinis*, *Chorizandra enodis*, *Eleocharis keigheryi*, *Leptocarpus coangustatus* and *Liparophyllum capitatum* (Figure 17).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Greek *porphyreos* (purple), referring to the distinct purple backs of the perianth lobes.

Notes. *Tribonanthes porphyrea* has been most often misidentified as *T. longipetala*, probably due to its relatively large and long perianth lobes. It differs from *T. longipetala* in having cream stamen connective appendages rather than yellow stamen connective appendages, a single-flowered inflorescence, velvety white trichomes on the inner surface of the perianth lobes and deep purple, sparsely hairy outer perianth lobes, rather than the silky white trichomes that cover both inner and outer surface of the perianth lobes of *T. longipetala*, and a short peduncle. It is similar to *T. longipetala* in having a tuft of silky white trichomes on top of the stigma. *Tribonanthes porphyrea* has also been misidentified as *T. violacea* probably due to the deep purple colouration of the outer surface of the perianth lobes

and the tendency of the plants to turn purple as they senesce. It differs from *T. violacea* in having a prominent crown of stamen connective appendages, rather than the small to residual stamen connective appendages of *T. violacea*. Most *Tribonanthes* species have their point of basal leaf attachment to the aerial stem at or just below the soil surface. *Tribonanthes porphyrea* differs in sometimes having its point of leaf attachment above the soil surface to a height of 75 mm (Figure 16). As this species is often growing in standing water this extension of the aerial stem, below the point of leaf attachment, may be a mechanism to keep its 'head above water'.

6. Tribonanthes elongata E.J.Hickman & Hopper, *sp. nov.*

Type: Watershed Road, 4.5 km north of intersection with Basin Road, south-east side of road on wet flat, Mount Romance area of State Forest, north-west of Denmark, Western Australia, 3 November 2014, *E.J. Hickman* 2073 (*holo*: PERTH 08986967; *iso*: CANB).

Illustration. M. Corrick, *Wildflowers of southern W. Austral*. p. 86 (1996) (as *T. australis*).

Herb annually renewed from a white ovoid corm, 8.5–16.7 cm tall above ground, consisting of a single stem and single leaf. *Corms* 10–15 mm diameter, covered by numerous old brown, papery sheaths, 1.7–5.7 cm below soil surface. *Roots* white, with a few scattered small white root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf and inflorescence bract) 2–8.8 cm, lower 3/4 glabrous, the remainder with a few trichomes. *Basal leaf* 3.6–18.4 cm long, erect, the stem-clasping base red-purple grading to green with darker green longitudinal striations and red margin, top becoming terete with a mucronate tip, glabrous. *Inflorescence bract* 1.2–4.8 cm long, erect, the stem-clasping base 5–8 mm circumference at widest point, red-purple base grading to green with darker green longitudinal striations and red to purple margins with no fringing trichomes; lamina 3–23 mm long, terete, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 2.6–8.7 cm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 8–17 mm long, 3–8 mm wide, lanceolate, green, with prominent longitudinal veins, membranous, with hairy margins, hairy at base of outside surface, glabrous inside surface, apex shortly terete, 1–3 mm long, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 8–14 mm long, 2–5 mm wide, spreading to recurved, oblong, white velvety hairy inner and outer surfaces, with purple tinge along midline of outer surface, dark mucronate tip. *Perianth tube* 4–7.9 mm long, outer surface covered in white silky trichomes forming a distinct skirt at the base, inner surface pale green, glabrous. *Stamen connective appendages* small, 1.1–2.6 mm long, 1.1–1.3 mm wide, yellow, topped with 5 short pointed tips, their apices below anther tips, transparent trichomes on inner surface below anther. *Anthers* 2.5–3.9 mm long, yellow, with a deep yellow sterile apex that projects slightly towards centre of flower, attached centrally on stamen connective appendage. *Ovary* green, inferior, locules 3 with several (26) ovules per locule. *Style* short to almost absent, 0.4–1.5 mm long, with green and purple longitudinal striations. *Stigma* capitate, green, with prominent tuft of white silky trichomes on top. *Capsule* greyish brown; perianth persistent; lobes spreading before dehiscence, more reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 18, 19)

Diagnostic features. Medium plant, terete leaf, long peduncle, solitary flowered inflorescence, velvety white flowers with long narrow perianth lobes, small yellow stamen connective appendages, short to sub-sessile style, stigma with prominent tuft of silky white trichomes on top, inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: 10 km SW of Goomalling on Goomalling–Toodyay Rd, 31 Aug. 1993, *P. Armstrong s.n.* (PERTH); Parkerville, 5 Sep. 1976, *R. Coveny* 8058

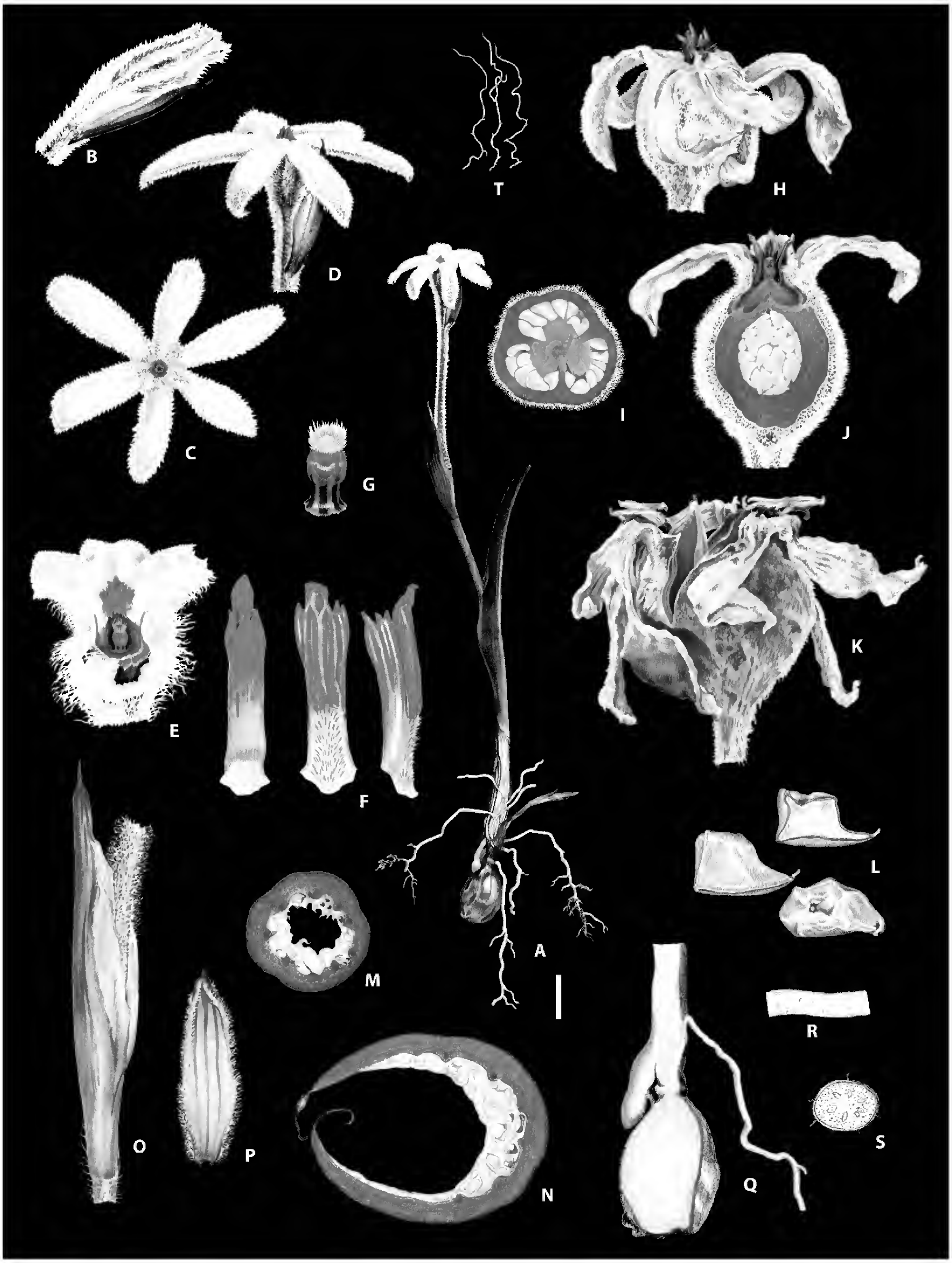

Figure 18. *Tribonanthes elongata*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from back, front and side view showing yellow stamen connective appendages shorter than anthers, fine trichomes on filaments below anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of silky white trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – infloresence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 4 mm (B, C, D, Q); 2.5 mm (E, H, I, J, K, O, P); 1 mm (F, G, L, M, N, R); 0.5 mm (S); 0.65 mm (T). Drawn from fresh material *E.J. Hickman* 2073 (PERTH 08986967). Illustrations by E.J. Hickman.

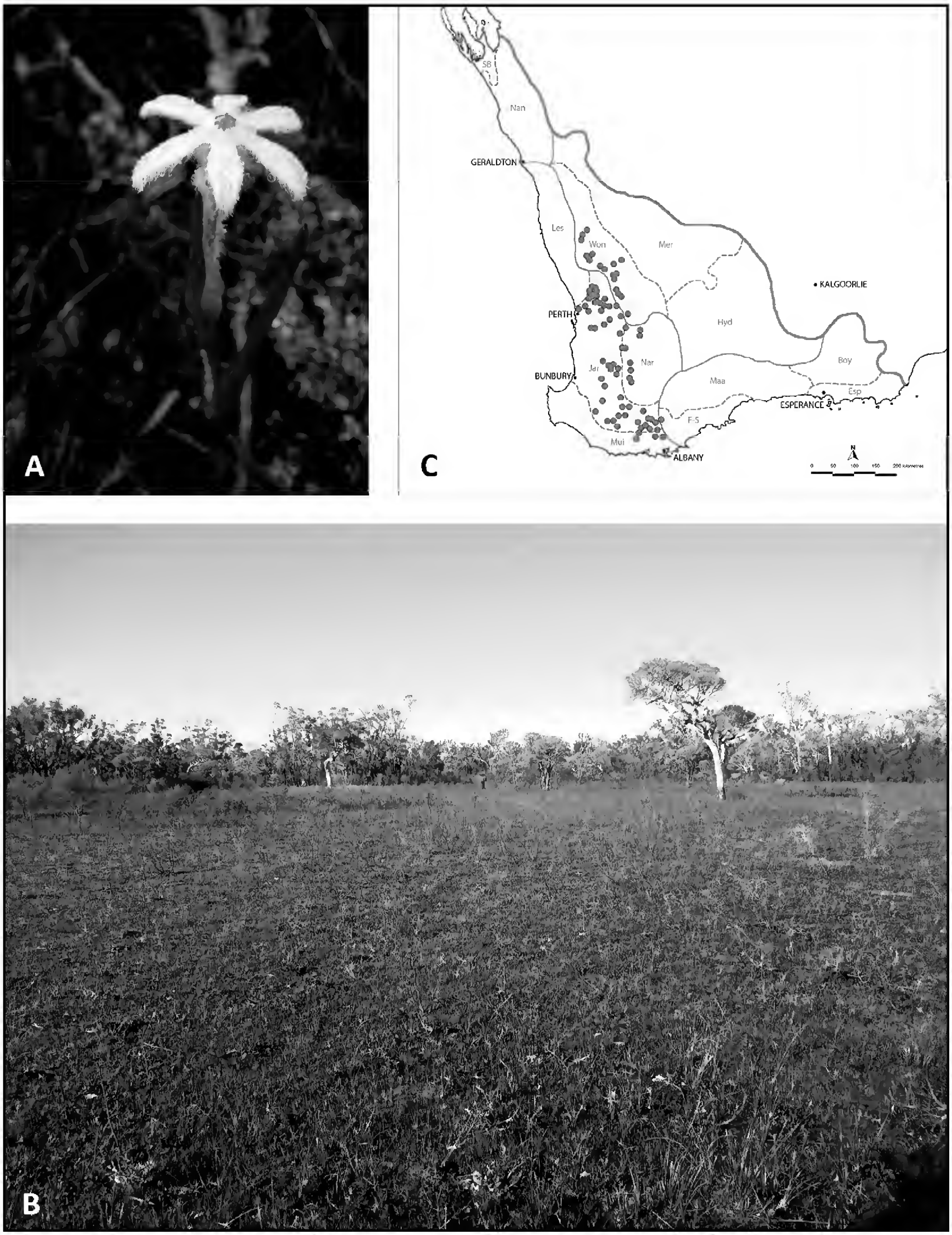

Figure 19. *Tribonanthes elongata*. A – single-flowered inflorescence with white woolly hairy spreading perianth lobes, and yellow stamen connective appendages (*E.J. Hickman* 2073); B – habitat (*E.J. Hickman* 2073), burnt, seasonal wet flat, dominated by *Melaleuca* spp. shrubland, surrounded by Jarrah/Marri woodland, on Watershed Road, Mt Romance area of the state forest, north-west of Denmark, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

(PERTH); Moorialup Rd, E of Porongurups, 30 Aug. 1983, *D. Davidson s.n.* (PERTH); Jingaring Reserve, ESE of Brookton, 1 Sep. 1998, *R. Davis* 6527 (PERTH); Hillman Forest Block, 27 Sep. 2006, *S. Fisher* BNC 1070 (PERTH); Beaufort River Bridge Nature Reserve, N of bridge, E of Albany Hwy, 18 Aug. 2014, *E.J. Hickman* 2012 (PERTH); Northam–Pithara Rd, 400 m S of Konnongorring West Rd, E side of road at base of W sloping sheet of granite, 11 Sep. 2014, *E.J. Hickman* 2046 (PERTH); Nollajup Nature Reserve, Jayes Rd, 11.5 km E from Bridgetown–Boyup Brook Rd, N side of road around granite outcrop, 20 Sep. 2014, *E.J. Hickman* 2058 (PERTH); Mettabinup Nature Reserve, 3.3 km W on Flora and Fauna Rd from Tone Rd, then 500 m W into reserve to the SW boundary, 20 Sep. 2014, *E.J. Hickman* 2059 (PERTH); reserve on Frankland–Cranbrook Rd, 100 m N on Addis Rd from Frankland–Cranbrook Rd, 20 Sep. 2014, *E.J. Hickman* 2063 (PERTH); Wamballup Lake Nature Reserve, 500 m W on Wamballup Rd from Boyup Rd, S side of road in broad drainage line, 30 Sep. 2014, *E.J. Hickman* 2064 (PERTH); Mokine Nature Reserve, WSW of Northam, 2 Aug. 1985, *G.J. Keighery* 7794 (PERTH); Lake Muir Nature Reserve, NE side of Lake Muir, 27 Aug. 1998, *G.J. Keighery* 15411 (PERTH); Poison Paddock, New Norcia, 5 Aug. 2004, *K. Macey* 594 (PERTH); 14 km N of Moora from Moore River Bridge, along road to Geraldton, 27 July 1982, *T.D. Macfarlane* 856 (PERTH); Mount Hardey Reserve, 19 Aug. 1998, *J. Monks* JM 108 (PERTH); Beverley Airfield Reserve, 27 Sep. 2000, *M. Ochtman* BAR 109 (PERTH); Dryandra State Forest, 30 Aug. 1988, *D. Rose* 669 (PERTH); Sullivan Rock S of Armadale, 30 Aug. 1992, *P.J. Rudall* 20 (PERTH); 21 km from Collie towards Darkan, 22 Sep. 1983, *J. Taylor & P. Ollerenshaw* JT2101 (PERTH); Reserve 424A, Talbot West Road, York, 9 Aug. 2003, *C. & A. Warburton* AW 27 (PERTH); Highbury Block State Forest, 15 Oct. 1999, *G. Warren, C. Taylor & P. Rose* 315 (PERTH).

Proposed vernacular name. Brilliant-flowered Tiurndin.

Phenology. Flowers from August to October.

Distribution and habitat. *Tribonanthes elongata* is known from Watheroo in the north to the Porongurup Range in the south and from Perth east of the Darling Scarp to Pingelly. Most populations occur within the Jarrah, Narrogin and Muir Districts of the Bibbulmun Province and Wongan District of the Transitional Rainfall Province of south-west Western Australia, but one population is on the border of the Jarrah District of the Bibbulmun Province and the Fitzgerald-Stirling District of the Southeast Coastal Province (Gioia & Hopper 2017). *Tribonanthes elongata* grows on brown to grey sandy loam to sandy clay, on winter wet flats and at the base of granite outcrops that support open woodlands, shrublands and herbfields. Associated species include *Eucalyptus rudis*, *E. wandoo*, *E. loxophleba*, *E. marginata*, *E. occidentalis*, *Corymbia calophylla*, *Allocasuarina* spp., *Melaleuca preissiana*, *M. viminea*, *Hakea* spp., *Acacia acuminata* and various herbs and sedges (Figure 19).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin *elongatus* (elongated), referring to the long perianth lobes of this species.

Notes. Based on determinations on herbarium specimens, Macfarlane (1987) included our *Tribonanthes elongata* in his concept of *T. longipetala*. However, *T. elongata* differs from *T. longipetala* in having terete leaves, a smaller stature and a single-flowered inflorescence. *Tribonanthes elongata* also has a more widespread distribution, in winter wet areas throughout the SWAFR, while *T. longipetala* is generally found in seasonally wet areas on the slopes of the Darling Scarp. The other significant difference between these two species is that *T. elongata* has fine transparent trichomes on the inside of the filament below the anther, while *T. longipetala* has glabrous filaments.

7. Tribonanthes keigheryi E.J.Hickman & Hopper, *sp. nov.*

Type: Wamballup Lake Nature Reserve, 500 m west along Wamballup Road from Boyup Road, south side of road in broad drainage line, Western Australia, 30 September 2014, *E.J. Hickman* 2065 (*holo*: PERTH 08986940; *iso*: CANB).

Tribonanthes sp. Lake Muir (G.J. Keighery & N. Gibson 2134), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 1 Feb. 2019].

Illustration. Nil other than those herein.

Herb annually renewed from a white ovoid corm, 3.0–26.5 cm tall above ground, consisting of a single stem and single leaf. *Corms* 6.4–6.8 mm diameter, covered by numerous old brown, papery sheaths, 1.5–4.6 cm below soil surface. *Roots* white, with no root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 2–23 cm, glabrous. *Basal leaf* 4.4–17.5 cm long, erect, stem-clasping to filiform, deep red-purple base grading to green, glabrous, with mucronate tip. *Inflorescence bract* 0.8–6.1 cm long, erect, funnel-like sheath with broad dilated mouth, 4–9 mm circumference at widest point, green with broad transparent membranous margins, sometimes tinged pink, fringed at top with fine white trichomes; lamina 5–44 mm long, filiform, green, glabrous, with a dark mucronate tip. *Peduncle* (from inflorescence bract to floral bract) absent, or if present to 0.7 cm long, with very few scattered trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 4–11 mm long, 1.5–6 mm wide, orbicular to ovate, green with broad membranous margin tinged pink and fringed with white trichomes, otherwise glabrous, apex 0.5–3 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 3–6 mm long, 1.5–3 mm wide, spreading to erect, obovate, inner surface white woolly hairy, on outer surface sparsely hairy with broad central purple or green stripe. *Perianth tube* 2.5–5 mm long, outer surface green with few scattered white trichomes, inner surface white and glabrous. *Stamen connective appendages* small to residual 0–1.5 mm long, 0.7 mm wide, white with purple tinged spot where anther attaches, two pointed tips, their apices below anther tip. *Anthers* 0.7–2 mm long, yellow, with small paler yellow sterile apex that projects upwards, attached at top of the stamen connective appendage. *Ovary* green, half-inferior, locules 3 with several (14) ovules per locule. *Style* relatively long, 0.7–2.5 mm, green. *Stigma* capitate, yellow, with few short trichomes on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 20, 21)

Diagnostic features. Medium plant, filiform leaf, short peduncles, solitary-flowered inflorescence, woolly white flowers with purple sparsely hairy outer surfaces, small to residual white stamen connective appendages, long style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Kangaroo Rd, 4.1 km E of Collis Rd, 14 Sep. 1994, *A.R. Annels & R.W. Hearn* ARA 4416 (PERTH); Wandoo Conservation Park, Goonapping Swamp, 17 Sep. 2014, *K.L. Brown & G. Paczkowska* KLB 1154 (PERTH); Brockman Highway, 6 Oct. 2000, *R. Cranfield* 15475 (PERTH); Coalfields Rd, 4 km NE of Bowelling, 25 Sep. 1995, *V. Crowley* DKN 70 (PERTH); King George Sound, 1 Dec. 1900, *Col. Goadby* B2063 (PERTH); Lake Muir Nature Reserve, 5.9 km W of Unicup Rd on Muirs Hwy, 60 m S of road side, 17 Oct. 2013, *E.J. Hickman* 2001 (PERTH); Kulunilup Nature Reserve, 2.3 km S of Wingebellup Rd on Unicup Rd, E side of road, 17 Oct. 2013, *E.J. Hickman* 2002 (PERTH); Cobertup Nature Reserve, 2.5 km N on Noobijup Rd from Muirs Hwy, 400 m W along N boundary firebreak, 17 Oct. 2013, *E.J. Hickman* 2004 (PERTH); Wimballup Swamp, NW side, 3.8 km W of Frankland River bridge, 2.9 km S on track to

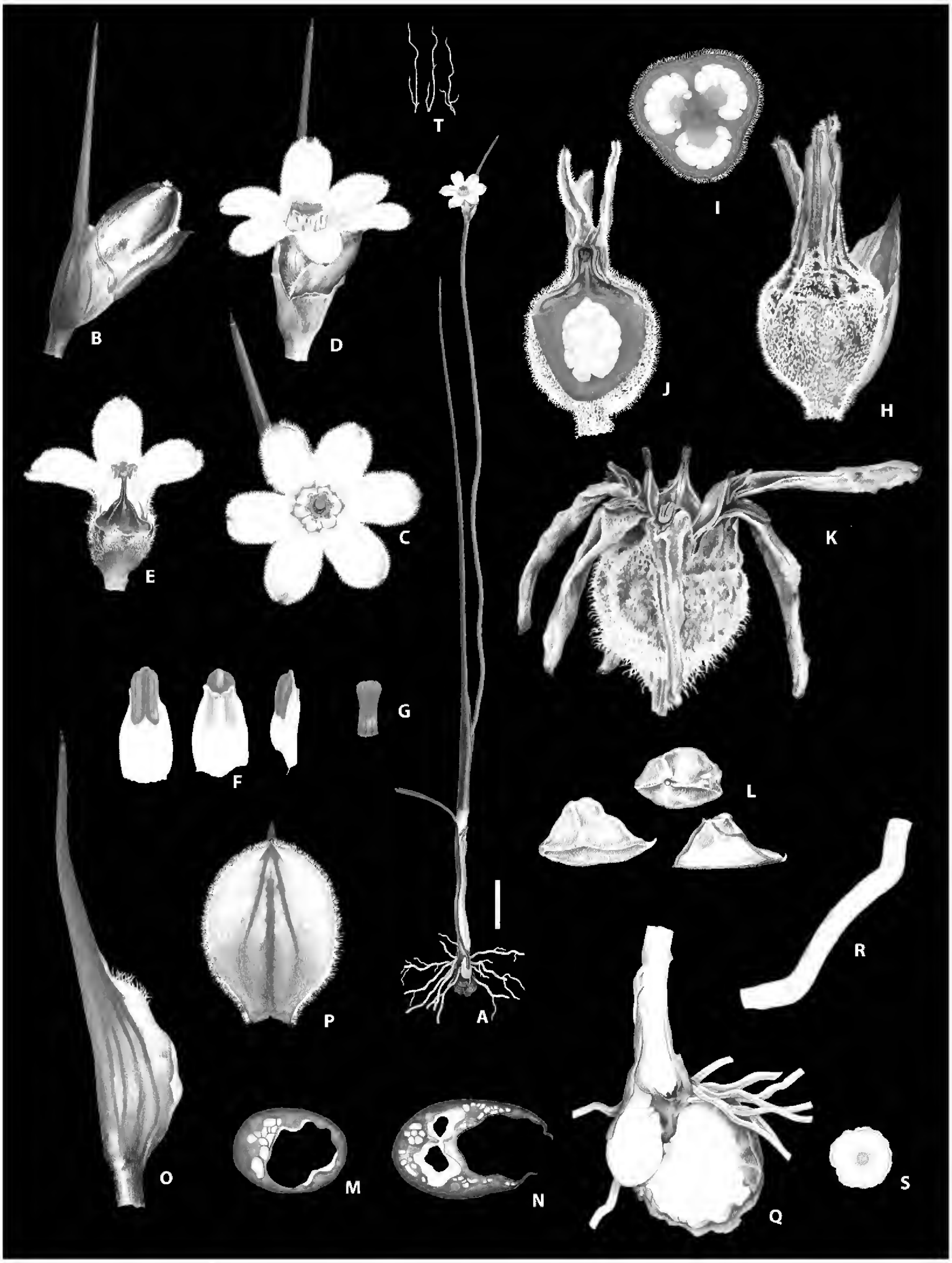

Figure 20. *Tribonanthes keigheryi*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, back and side view showing stamen connective appendages scarcely developed, much shorter than anthers and yellow anthers without prominent apiculate apex; G – style elongated with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex (hollow); N – leaf section near base (hollow); O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, O, P, Q); 1 mm (F, G, L); 2 mm (H, I, J, K); 0.65 mm (M, N); 1.25 mm (R); 0.5 mm (S); 0.4 mm (T). Drawn from fresh material *E.J. Hickman* 2065 (PERTH 08986940). Illustrations by E.J. Hickman.

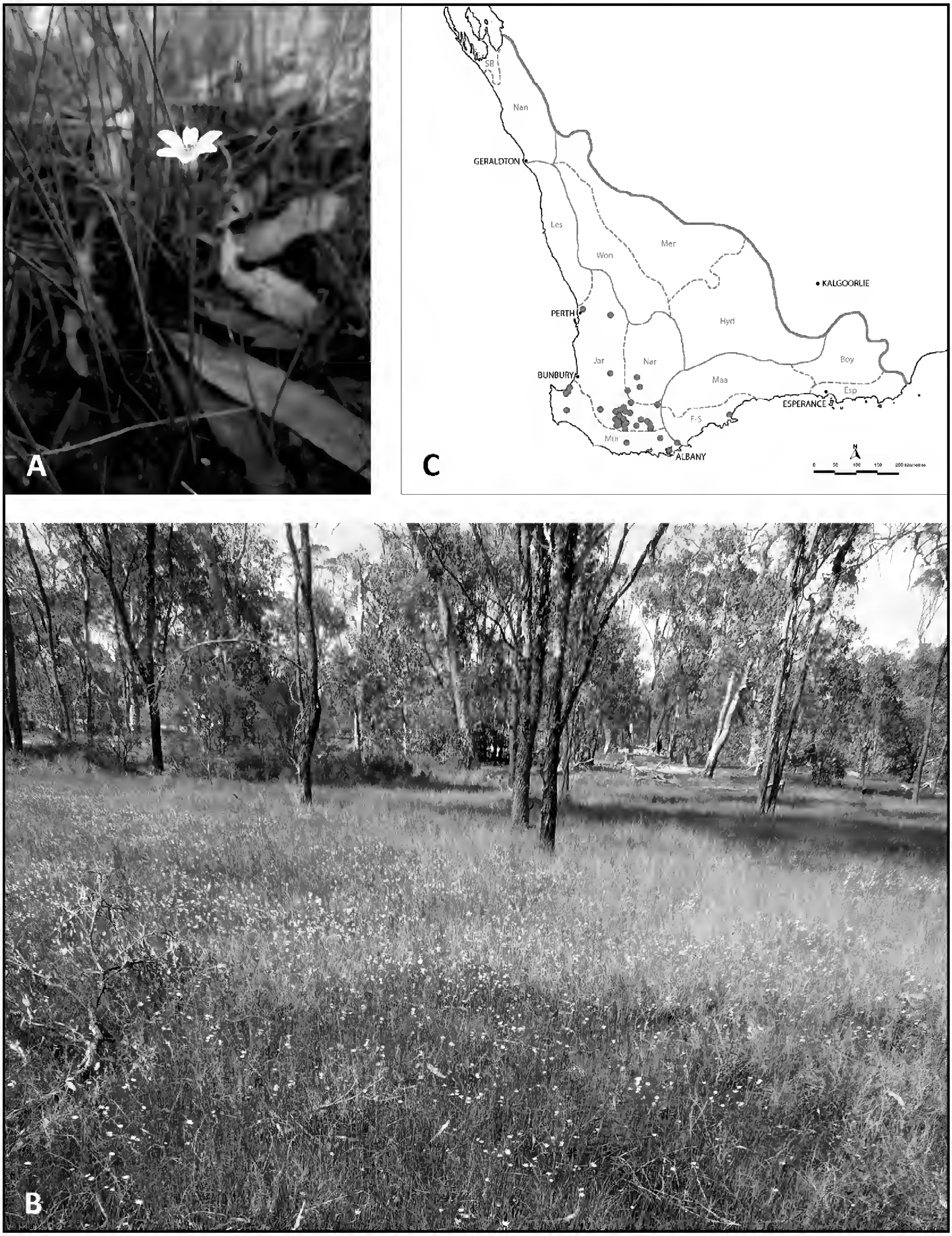

Figure 21. *Tribonanthes keigheryi*. A – small single-flowered inflorescence with white woolly hairy spreading perianth lobes, and minute stamen connective appendages (*E.J. Hickman* 2065); B – habitat (*E.J. Hickman* 2065), seasonally wet flat, in open *Eucalyptus occidentalis* and *E. rudis* woodland, Wamballup Lake Nature Reserve, west of Kendenup; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Neerabup Rd, 5.5 km W to site, 23 Oct. 2013, *E.J. Hickman* 2005 (PERTH); Cannington, 28 July 1973 *G.J. Keighery* 366 (PERTH); 1 km S of Tambellup to Cranbrook, 20 Oct. 1983, *G.J. Keighery* 6715 (PERTH); Beaufort River Water Reserve, 7 Oct. 2003, *G.J. Keighery* 16357 (PERTH); Yoongarillup Townsite Reserve, SE of Busselton, 15 Sep. 2006, *G.J. Keighery* 17045 (PERTH); South West Hwy, 6.5 km N of Palgarup, 12 Oct. 1983, *T.D. Macfarlane* 1244 (PERTH); Tooregullup Swamp, 15 km NE of Bremer Bay, 25 Sep. 1976, *K.R. Newbey* 4987 (PERTH); Wandoo National Park, 4 Oct. 2007, *M. Wheeler, P. Armstrong & students* 480 (PERTH).

Proposed vernacular name. Keighery's Tiurndin.

Phenology. Flowers from August to October.

Distribution and habitat. The distribution of *T. keigheryi* is broadly scattered from Perth to north-east of Bremer Bay, but the majority of populations are located around the wetlands and swamps between Manjimup and Mt Barker, where the plants are often in standing water. Populations are concentrated in the Jarrah and Muir Districts of the Bibbulmun Province of the south-west of Western Australia (Gioia & Hopper 2017), but also occur in the Narrogin District of the Bibbulmun Province, and Fitzgerald–Stirling District of the Southeast Coastal Province. *Tribonanthes keigheryi* grows on grey to brown sand, sandy clay or clay, in the winter wet flats, valley floors and wetlands that support open woodlands, and sedgelands. Associated species include *Eucalyptus rudis*, *E. wandoo*, *E. occidentalis*, *Corymbia calophylla*, *Melaleuca rhaphiophylla*, *M. cuticularis*, *M. viminea*, *M. lateritia*, *Hakea prostrata*, *H. varia Callistemon phoeniceus*, *Hypocalymma angustifolium*, *Chorizandra enodis*, *Leptocarpus* spp., *Ornduffia submersa* and *Pauridia* spp. (Figure 21).

Conservation status. Widespread with no special conservation needs. When first recognised, *T. keigheryi* was listed as Priority Three (Smith & Jones 2018). However, in light of the present study, this species has been shown to be widespread with no special need for conservation and it has consequently been de-listed.

Etymology. Named for Gregory J. Keighery, survey botanist with the Department of Conservation and Land Management and its successors, for his many contributions to the study of Western Australian flora and vegetation. Greg has an encyclopaedic knowledge of plant names and has become one of the most prolific collectors of Western Australian plants, as well as naming more than 100 new species. The specific epithet is pronounced 'key-er-ee-eye'.

Notes. *Tribonanthes keigheryi* differs from *T. violacea* in having a slenderer habit and smaller flowers. This difference was noted by Greg Keighery with specimens he first collected in 1997 and lodged at the Western Australian Herbarium with the designation *Tribonanthes* sp. Lake Muir.

8. Tribonanthes variabilis Lindl., *Sketch Veg. Swan R.* xliv (1840).

Type: Damp places, The Vasse, Western Australia, *Mrs Molloy p.p.* (*lecto*: CGE23342! all plants except second from the left, *fide* T.D. Macfarlane, *Fl. Australia* 45: 465 (1987); possible *isolecto*: K000356597 image!).

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.* Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); T.D. Macfarlane *Fl. Australia* 45: 135 Figure 52 F–I (1987);

M. Simpson, Haemodoraceae, *in* K. Kubitzki, *Fam. Gen. vascular plants* IV, p. 213, Figure 54 A–B (1998); J.R. Wheeler *in* J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* 1: 313 (2002).

Herb annually renewed from a white ovoid corm, 13.6–39 cm tall above ground, consisting of a single stem and 1(–2) leaves, the basal leaf and sometimes a cauline leaf. *Corms* 7–10 mm diameter, covered by numerous old brown, papery sheaths, 2.7–6.0 cm below soil surface. *Roots* white, with rootlets but no visible root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 3.2–18 cm, glabrous. *Basal leaf* 6.8–21.7 cm long, erect, stem-clasping to terete, red-purple below grading to deep green, with dark mucronate tip, glabrous, some plants with a cauline leaf on the aerial stem between the basal leaf and the inflorescence bract. *Cauline leaf* similar to basal leaf only shorter. *Inflorescence bract* 2.7–14.5 cm long, erect funnel-like sheath, 4–11 mm circumference at widest point; lamina 5–80 mm long, terete, green, with a narrow membranous margin and darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to floral bract) 6.8–28 cm long, lower 1/2 becoming sparsely hairy, the remainder covered in white woolly trichomes. *Inflorescence* a compact cyme of 2–7 shortly to moderately long-pedicellate flowers, each subtended by a single floral bract. *Floral bract* 7–18 mm long, 3.5–8.5 mm wide, lanceolate, green with one to several darker longitudinal striations, membranous margin fringed with white trichomes, outside surface hairy at base, inside surface glabrous, apical part 1–6 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 5–12 mm long, 2–6 mm wide, spreading, dilated toward the apex, inner and outer surfaces creamy white hairy, with a darker mucronate tip. *Perianth tube* 3.5–9.0 mm long, outer surface covered in long silky creamy white trichomes, inner surface green, glabrous. *Stamen connective appendages* 3–6 mm long, 1.5–1.7 mm wide, creamy white, topped with 4 or 5 finger-like projections with pointed tips, exceeding anther tips. *Anthers* 2–4 mm long, yellow, with cream to pink sterile apex that projects upwards, attached centrally on stamen connective appendages. *Ovary* green, half-inferior to inferior, locules 3 with many (26) ovules per locule. *Style* short to almost absent, 0.4–2 mm long, dark greenish purple. *Stigma* capitate, green, with elongated tip topped with three glandular protuberances and covered in white trichomes. *Capsule* greyish brown; perianth persistent; lobes spreading before dehiscence, reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 22, 23)

Diagnostic features. Tall plant, terete leaf, long peduncles, multi-flowered inflorescence, woolly creamy white flowers with perianth lobes dilated toward the apex, cream stamen connective appendages, short to almost absent style with stigma bearing an elongated tip topped with three glandular protuberances and covered in white trichomes, half-inferior to inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Brand Hwy, 2.2 km W of Eneabba, 26 Aug. 1985, *M.E. Ballingall* 1955 (PERTH); Lake Wannamal Nature Reserve, 1 km E of Bindoon–Moora Rd, 9 Sep. 2014, *K.L. Brown & G. Paczkowska* KLB 1150 (PERTH); Surprise Forest Block, 2.8 km W of Nornalup Rd on Mountain Rd, 22 Nov. 2004, *R.J. Cranfield & B.G. Ward* WFM 298 (PERTH); Kooljerrenup Nature Reserve, 11 Sep. 2003, *P. Foreman & J. Kelly* KO 275 (PERTH); Leda Nature Reserve, 1.2 km S of Beekeepers Rd, 6 km W of Brand Hwy, 20 Aug. 2014, *E.J. Hickman* 2014 (PERTH); Marchagee Track, 2 km W of intersection with Dewars Rd, S side of road and S side of Dewars Creek, 20 Aug. 2014, *E.J. Hickman* 2017 (PERTH); Bashford Nature Reserve, SE corner of reserve, Bootoo Rd, E of Indian Ocean Dve, 28 Aug. 2014, *E.J. Hickman* 2026 (PERTH); Munbinea Rd, 10 km S of Bibby Rd, W side of road, 28 Aug. 2014, *E.J. Hickman* 2028 (PERTH); Cantabilling Rd, 3.5 km E of Munbinea Road, S side of road, 29 Aug. 2014, *E.J. Hickman* 2035 (PERTH); Ambergate Regional Park, Queen Elizabeth Ave., 150 m N of Doyle Rd, and 100 m W of road side, 19 Sep. 2014, *E.J. Hickman* 2053 (PERTH); Albany Hwy, 8.6 km S of Mt Cooke turn-off, 9 Nov. 1975, *S.D. Hopper* 842 (PERTH); Blackwood River bridge, 11 km E of Boyup Brook, 13 Nov. 1975, *S.D. Hopper* 882

Figure 22. *Tribonanthes variabilis*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing creamy white stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting upwards; G – style sub-sessile with distinct tuft of white silky trichomes on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, H, I, J, K, P); 1 mm (F, G, M, N); 0.5 mm (L, S); 5 mm (O); 4 mm (Q); 2 mm (R); 0.65 mm (T). Drawn from fresh material *E.J. Hickman* 2053 (PERTH 08986975). Illustrations by E.J. Hickman.

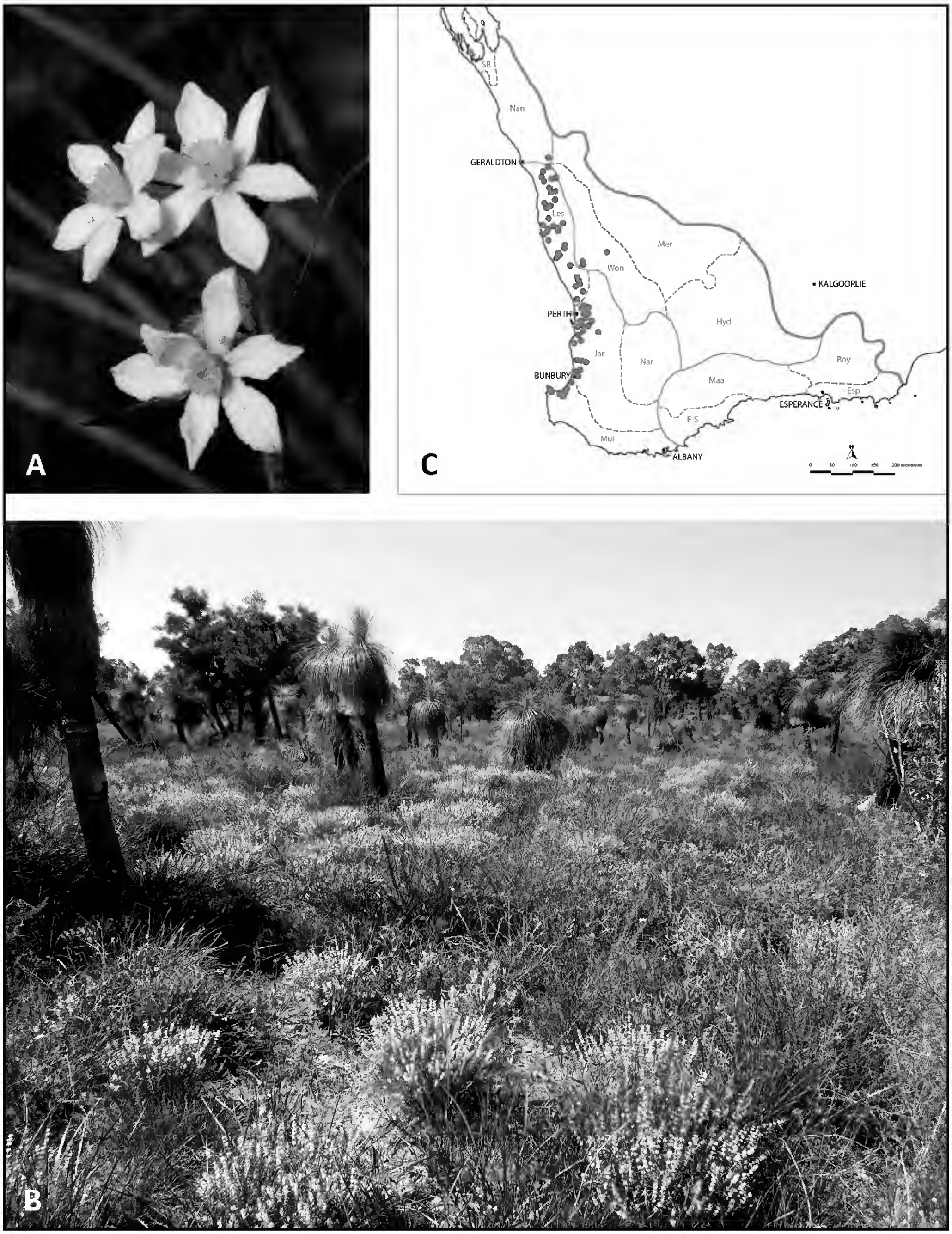

Figure 23. *Tribonanthes variabilis*. A – multi-flowered inflorescence with white woolly hairy spreading perianth lobes, and corona of cream stamen connective appendages (*E.J. Hickman* 2035); B – habitat (*E.J. Hickman* 2053), seasonally wet flat, in open *Corymbia calophylla* woodland, with dominant species *Kingia australis*, *Xanthorrhoea preissii*, *Hypocalymma angustifolium*, *Adenanthos obovatus*, *Stirlingia latifolia*, *Synaphea* sp., *Nuytsia floribunda*, Ambergate Regional Park, south of Busselton, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

(PERTH); Ring Rd, Bunbury, 19 Sep. 1983, *G.J. Keighery* 6436 (PERTH); Nullilla Nature Reserve, Gingin, 14 Sep. 2005 *G.J. Keighery* 16580 (PERTH); Harvey River District, Nov. 1901, *Miss Lambert* 814 (PERTH); Wongonderrah Rd, 9 km E of turn-off from Nambung Homestead, 30 Oct. 1999, *C. MacPherson s.n.* (PERTH); Manjimup, 28 Sep. 1948, *R.D. Royce* 2710 (PERTH); Wongan Hills, 9 Aug. 1949, *E. Salisbury s.n.* (PERTH); Augusta, 28 Aug. 2001, *J. Scott* 421 (PERTH); Brixton Street Wetlands, Kenwick, E of Brixton St and N of Wanaping Rd, 17 Aug. 2009, *K.R. Thiele* 3766 (PERTH).

Proposed vernacular name. Hairy-stigma Tiurndin.

Phenology. Flowers from August to November.

Distribution and habitat. *Tribonanthes variabilis* is found from near Geraldton along the west coast to Bunbury and inland to the Darling Scarp. Populations occur mainly within the Lesueur, Jarrah and Muir Districts of the Bibbulmun Province of the south-west of Western Australia (Gioia & Hopper 2017), but a few populations are located in the Wongan District of the Transitional Rainfall Province and the Nanda District of the Kalbarri Province. *Tribonanthes variabilis* grows on grey, brown, red-brown or black, sand, sandy clay, clay, sandy loam or peat in the winter wet flats, creek beds, along riversides and surroundings of granite outcrops, that support open woodlands, shrublands, heaths, sedgelands and herbfields. Associated species include *Corymbia calophylla*, *Eucalyptus rudis*, *E. loxophleba*, *Melaleuca rhaphiophylla*, *M. cuticularis*, *M. viminea*, *M. lateritia*, *M. uncinata*, *Acacia acuminata*, *A. lasiocalyx*, *Hakea ceratophylla*, *Viminaria juncea*, *Hypocalymma angustifolium* and *Xanthorrhoea preissii* (Figure 23).

Conservation status. Widespread with no special conservation needs.

Etymology. Latin for variable, originally referring to the variable nature of the stamen connective appendages within this species, of which two length conditions are mentioned in the original description of this species (Lindley 1839–40: 44), based on Georgiana Molloy collections of this species from the Vasse River (CBG 23342). As stated above, this specimen sheet actually contains two species; *T. variabilis* and *T. longipetala*, leading Lindley to describe two conditions for a single species.

Notes. Macfarlane (1987) synonymised *T. variabilis* with *T. australis*. However, *T. variabilis* and *T. australis* specimens can be distinguished by their stigmas. *Tribonanthes variabilis* has a prominent appendage covered in silky white trichomes, present on the top of the stigma, while *T. australis* only has a few scattered trichomes on the top of the stigma. In addition, the perianth of *T. variabilis* is creamy white, while *T. australis* has a purple tinge, and the perianth lobes of *T. variabilis* are dilated at the ends making their width broader relative to their length than in *T. australis*.

9. Tribonanthes violacea Endl. in Lehm., *Pl. Preiss.* 2: 28 (1846).

Type: Between mounts Elphinstone and Melville, Albany, Western Australia, 11 October 1840, *J.A.L. Preiss* 1562 (*holo*: LD 1811441 image!; *iso*: MEL 104289 image!, P 00753522 image!, L 1470274 image!).

Illustration. T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 J–M (1987).

Herb annually renewed from a white ovoid corm, 4.5–12.5 cm tall above ground, consisting of a single stem and single leaf. *Corms* 6.9–9.2 mm diameter, covered by numerous old brown, papery sheaths,

1–5 cm below soil surface. *Roots* white, with a few white rootlets, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 2.5–8 cm, glabrous. *Basal leaf* 4.5–11 cm long, spreading, stem-clasping to terete, deep red-purple below grading to green with deep red margins, with mucronate tip, glabrous. *Inflorescence bract* 1.5–6.9 cm long, funnel-like sheath with broad dilated mouth, 5–11 mm circumference at widest point; lamina 5–43 mm long, terete, green with broad transparent membranous margin tinged pink, mucronate tip, glabrous. *Peduncle* (from inflorescence bract to floral bract) absent, or if present to 1.5 cm long, with a few scattered trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 5–19 mm long, 5–11 mm wide, orbicular to ovate, green with one to several darker longitudinal striations, broad membranous margin tinged pink and fringed with white trichomes, otherwise glabrous, apex 0.5–5 mm long, terete, ending in a darker tip, exceeding perianth lobes. *Perianth lobes* 4–9 mm long, 2–5 mm wide, spreading to erect, obtuse, white woolly hairy inner surface and sparsely hairy with broad central purple stripe on outer surface. *Perianth tube* 3–7.5 mm long, outer surface covered in white trichomes, inner surface white, glabrous. *Stamen connective appendages* small to residual, 1–2.5 mm long, 1.3–1.5 mm wide, white with purple tinged spot where anther attaches, with two pointed tips, shorter than anthers. *Anthers* 1.2–3.1 mm long, yellow, with pale yellow sterile apex that projects upwards, attached at top of stamen connective appendage. *Ovary* green, half-inferior, locules 3 with many (55) ovules per locule. *Style* relatively long, 1–3.2 mm, green. *Stigma* capitate, simple, yellow, with few short trichomes on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, spreading to reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 24, 25)

Diagnostic features. Medium plant, leaf lamina terete, short peduncles, solitary flowered inflorescence, woolly white flowers with more sparsely hairy purple outer surface, small to residual white stamen connective appendages, relatively long style with simple stigma, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Mingenew, 12 July 1970, *A.M. Ashby* 3275 (PERTH); Carnaby Close, Barrens Beach Estate, Hopetoun, 22 Aug. 2004, *M. Bennett* 1121 (PERTH); Sandalwood Rd 1.5 km from Cape Riche camping area, 1 Oct. 2013, *G. Byrne* 4813 (PERTH); Wilyung Hill, Albany, 30 Aug. 2004, *R.J. Cranfield* 20469 (PERTH); Gravel pit 14 km N of Mullewa on Gascoyne Junction Rd, 14 Sep. 2005, *J. Docherty* 380 (PERTH); Cape Arid National Park, 2.5 km NW from Seal Creek Campsite on firebreak track, 27 Oct. 2013, *E.J. Hickman* 2006 (PERTH); N boundary of reserve S of Esperance Airport, 2.2 km W on Crawford Rd from Esperance–Coolgardie Rd, 28 Oct. 2013, *E.J. Hickman* 2008 (PERTH); Lort River, E bank 100 m N of bridge on South Coast Hwy, 28 Oct. 2013, *E.J. Hickman* 2009 (PERTH); Merivale, intersection of Merivale Rd and Cape le Grand Rd, on two granite hills, 1 Aug. 2016, *E.J. Hickman* 2090 (PERTH); parking bay 1.8 km N of Gibson on Coolgardie–Esperance Hwy, 6 Sep. 1982, *S.D. Hopper* 2507 (PERTH); Moore River National Park, Beermullah, 26 July 2008, *F. Hort & J. Hort* FH 3203 (PERTH); 9 km SE of Yornup, 11 Sep. 1981, *G.J. Keighery* 3995 (PERTH); 15.4 km S of Northampton along North West Coastal Hwy, 21 Aug. 1983, *C.M. Lynch* 24 (PERTH).

Proposed vernacular name. Violet Tiurndin.

Phenology. Flowers July to September.

Distribution and habitat. *Tribonanthes violacea* is known from scattered populations from Northampton, north of Geraldton, along the coast to Cape Arid National Park east of Esperance. Populations occur in the Nanda District of the Kalbarri Province, Merredin District of the Transitional Rainfall Province, Lesueur, Jarrah and Muir Districts of the Bibbulmun Province, and Fitzgerald-Stirling, Maalak, Boylya and Esperance Districts of the Southeast Coastal Province of the south-west of Western

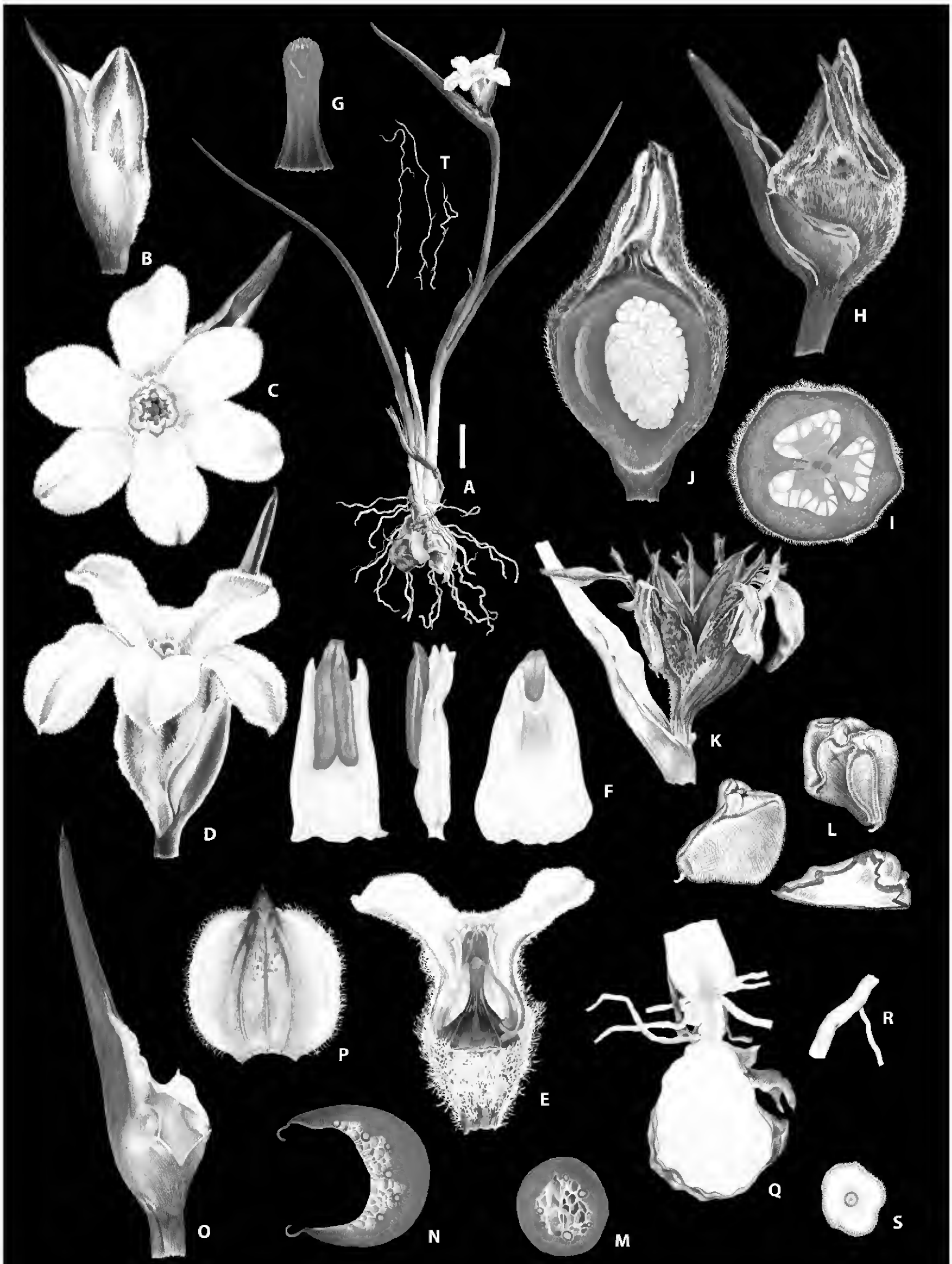

Figure 24. *Tribonanthes violacea*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing stamen connective appendages small, much shorter than anthers and yellow anthers with apex apiculate and projecting upwards; G – style elongated with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A); 2.5 mm (B, C, D, E, I, J, K, O, P, Q); 1 mm (F, G, M, N, T); 4 mm (H); 0.5 mm (L, S); 2 mm (R). Drawn from fresh material *E.J. Hickman* 2090 (PERTH 08989524). Illustrations by E.J. Hickman.

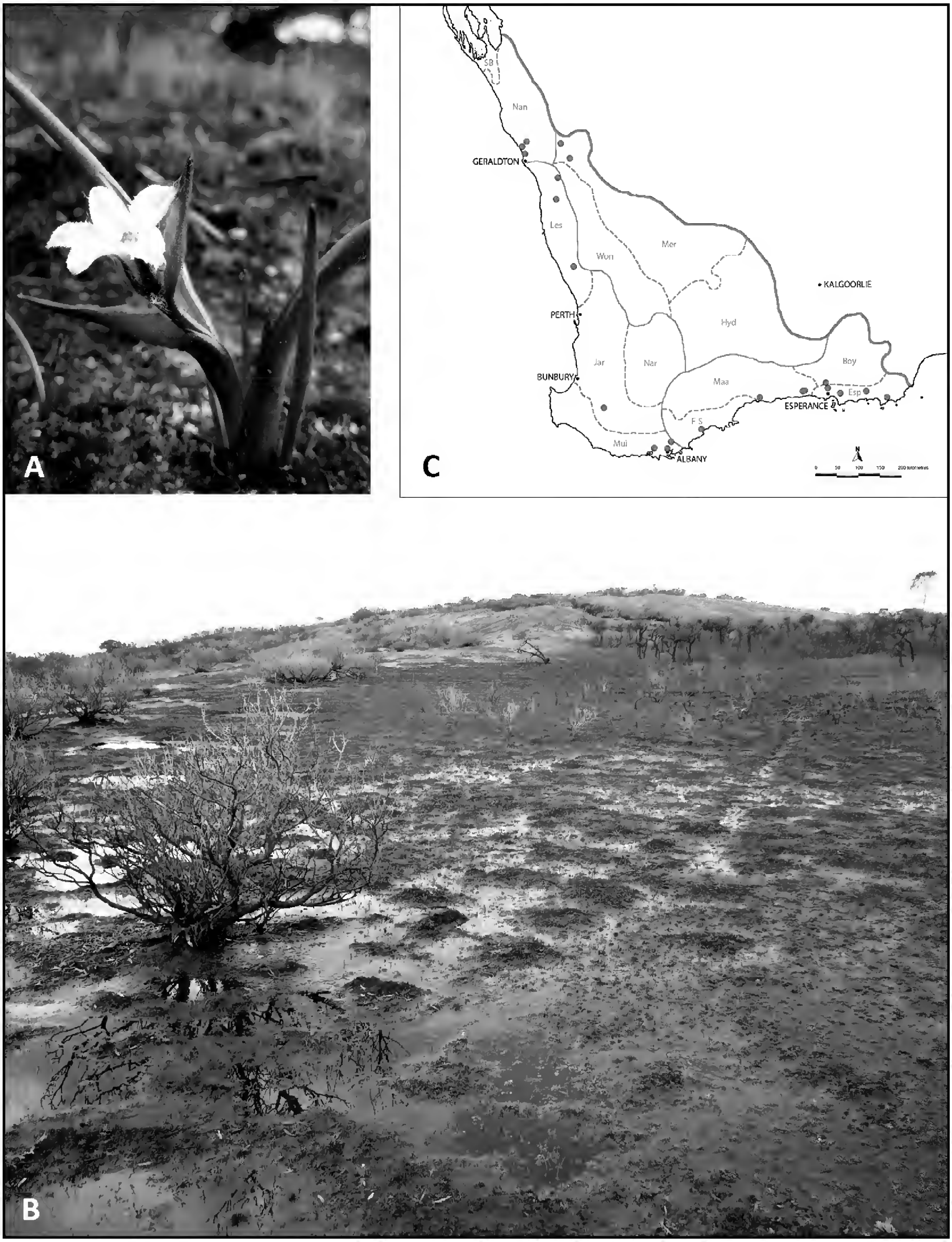

Figure 25. *Tribonanthes violacea*. A – single-flowered inflorescence with purple tinged, white woolly hairy spreading perianth lobes, on a short peduncle (*E.J. Hickman* 2090); B – habitat (*E.J. Hickman* 2090), mosaic of shrubland and moss swards on two granite hills at the intersection of Merivale Rd and Cape Le Grand Rd, Merivale, east of Esperance; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Australia (Gioia & Hopper 2017). *Tribonanthes violacea* grows on grey sand over clay associated with sandstone along creek lines and in winter wet depressions in the north and on grey sand over clay around granite outcrops or on wet winter flats in the south. These habitats support shrublands, open scrub, and heaths. Associated species include *Hakea* spp., *Melaleuca* spp., *Borya nitida*, and various herbs, sedges and grasses (Figure 25).

Conservation status. Widespread with no special conservation needs.

Etymology. From the Latin for violet colour, referring to the purple tinge of the flowers of this species.

Notes. A number of species have been misidentified as *T. violacea* in the past including *T. uniflora* and the newly described *T. keigheryi*, *T. monantha* and *T. porphyrea*. *Tribonanthes violacea* is similar to *T. keigheryi* and *T. porphyrea* in having a short to indistinguishable peduncle, but differs from *T. monantha* and *T. uniflora*, which have a relatively long peduncle covered in white woolly trichomes. *Tribonanthes violacea* is similar to *T. keigheryi* in having short to residual stamen connective appendages, which are often reduced to two small points on the tip of the filament, while *T. monantha*, *T. porphyrea* and *T. uniflora* have prominent stamen connective appendages forming a distinct corona-like structure. *Tribonanthes violacea* is similar to *T. monantha*, *T. keigheryi* and *T. uniflora* in having small flowers with the perianth lobes equal or shorter than the perianth tube but differs from *T. porphyrea* which has large flowers with perianth lobes longer than the perianth tube. *Tribonanthes violacea* is similar to *T. monantha* in having inflorescence bracts with a glabrous margin, by which it differs from *T. keigheryi*, *T. porphyrea* and *T. uniflora* which have a fringe of white simple trichomes along their inflorescence bract margins. *Tribonanthes violacea* is probably most similar to *T. keigheryi* but they are distinguished by *T. violacea* being a more robust plant that dwells in damp environments associated with granite outcrops, while *T. keigheryi* is a fine slender plant that prefers swampy habitats.

10. Tribonanthes brachypetala Lindl., *Sketch Veg. Swan R.* xliv (1840).

Type: Swan River, Western Australia, 1839, *J. Drummond s.n.* (*holo*: CGE 06823!; *iso*: K 000846203 image!, K 000846202 image!).

Tribonanthes odora Endl., in Lehm., *Pl. Preiss*. 2: 28 (1846), *nom. illeg.*, *nom. superfl. Type*: Canning River, Western Australia, 1840, *J.A.L. Preiss* 2394 (*holo*: LD 1811569 image!; *iso*: MEL 104290 image!, MEL 104291 image!, MEL 104292 image!, S 06-11227 image!).

Illustrations. W.E. Blackall & B.J. Grieve, *How to Know W. Austral. Wildfl.*, Part I, p. 75 (1954), reprinted as Parts I, II, III p. 75 (1974); T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 N–Q (1987); J.R. Wheeler *in* J. Wheeler, N. Marchant & M. Lewington, *Flora S.W.* 1: 313 (2002).

Herb annually renewed from a white ovoid corm, 21–41 cm tall above ground, consisting of a single stem and 2(–3) leaves, 1 basal and 1(–2) cauline. *Corms* 10–11 mm diameter, covered by numerous old brown, papery sheaths, 3.2–5.8 cm below soil surface. *Roots* white, with no visible root trichomes, no sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 3.5–20 cm, mostly glabrous except upper 1/4 sparsely hairy. *Basal leaf* 3.4–22 cm long, erect, stem-clasping to terete, deep green with dark mucronate tip, glabrous. *Cauline leaf* similar to basal leaf only shorter; some plants with 1(–2) cauline leaves positioned 1/3–1/2 way up aerial stem (Figure 26A1). *Inflorescence bract* 1.8–8.2 cm long, sheath funnel-like, with broad dilated mouth 6–9 mm circumference at widest point, green with thin membranous margins, glabrous; lamina 14–55 mm long, terete, green with

darker mucronate tip, glabrous. *Peduncle* (from inflorescence bract to first floral bract) 13–26.5 cm long, covered in white woolly trichomes, with the trichomes becoming sparser in the lower 1/2. *Inflorescence* a nodding compact cyme of 3–7 sessile or shortly pedicellate flowers, each subtended by a single floral bract. *Floral bracts* 6–24 mm long, 2–10 mm wide, lanceolate, asymmetric, green with one to several darker longitudinal striations, hairy margins, hairy at base on outside surface, glabrous inside surface, apex 1–15 mm long, terete, green ending in a darker tip. *Perianth lobes* 3.5–5 mm long, 2–3 mm wide, strongly reflexed, ovate to triangular, green with white hairy outer surface, glabrous inner surface, dark red mucronate tips. *Perianth tube* length 5.2–8 mm, outer surface covered in white woolly trichomes, inner surface mostly glabrous except for scattered trichomes near the base. *Stamen connective appendages* 2.5–4 mm long, 2.2 mm wide and 1.8 mm deep, fleshy, deeply grooved on back, well exceeding anther tips, forming a conspicuous crown-like structure, yellow. *Anthers* 2–3 mm long, yellow, with cream sterile apex that projects upwards, attached on lower part of stamen connective appendages. *Ovary* green, half-inferior, locules 3 with few (6) ovules per locule. *Style* short, 0.8–2 mm long, green. *Stigma* capitate, greenish yellow, topped with three short glandular protuberances and covered with short trichomes. *Capsule* greyish brown; perianth persistent; lobes reflexed before and spreading to reflexed after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 26, 27)

Diagnostic features. Tall plant, terete leaf, long peduncles, multi-flowered nodding inflorescence, perianth lobes strongly reflexed, very obvious yellow stamen connective appendages, short style, stigma with three glandular protuberances, half-inferior ovary.

Selected specimens examined. WESTERN AUSTRALIA: Gooseberry Hill, 170 m E of Watsonia Rd and 210 m N of Gooseberry Hill Rd, 27 Aug. 2014, *E.J. Hickman* 2022 (PERTH); Watershed Rd, 4.5 km N of intersection with Basin Rd, SE side of road on wet flat, 3 Nov. 2014, *E.J. Hickman* 2074 (PERTH); Tindale Rd, Kentdale, W of Denmark, 3 Aug. 1992, *S.D. Hopper* 7286 (PERTH); 18 km S of Bridgetown, near Yornup, 8 Oct. 1982, *G.J. Keighery* 5321 (PERTH); airport, SE Bunbury, 18 Sep. 1983, *G.J. Keighery* 6426 (PERTH); Ambergate Regional Park, S of Busselton, 13 Sep. 1994, *G.J. Keighery* 13398 (PERTH); Yoongarillup Townsite Reserve, SE of Busselton, 15 Sep. 2006, *G.J. Keighery* 17030 (PERTH); Serpentine townsite, 19 Oct. 1983, *T.D. Macfarlane* 1291 (PERTH); W of Harvey, 21 Sep. 1948, *R.D. Royce* 2654 (PERTH); Unicup Rd off Muir Hwy, 19 Sep. 1987, *M. Sherwood* 869 (PERTH).

Proposed vernacular name. Nodding Tiurndin.

Phenology. Flowers from July to October.

Distribution and habitat. *Tribonanthes brachypetala* has been collected from north east of Perth on and west of the Darling Scarp, to Dunsborough, and south-east through the state forest to Mt Barker. Its most easterly population is at the base of the southern slopes of the Porongurup Range. Its distribution is concentrated along the western edge of the Bibbulmun Province of south-west Western Australia (Gioia & Hopper 2017), mainly in the Jarrah and Muir Districts. Its easterly population is on the border of the Muir District and Fitzgerald-Stirling District of the Southeast Coastal Province. It grows on seasonally wet brown loams around granite outcrops associated with open woodlands, and on black to grey peaty or sandy clays in winter wet flats associated with open woodlands. Associated species include *Corymbia calophylla*, *Eucalyptus marginata*, *E. wandoo*, *Melaleuca rhaphiophylla* and *Xanthorrhoea preissii* (Figure 27).

Conservation status. Widespread with no special conservation needs.

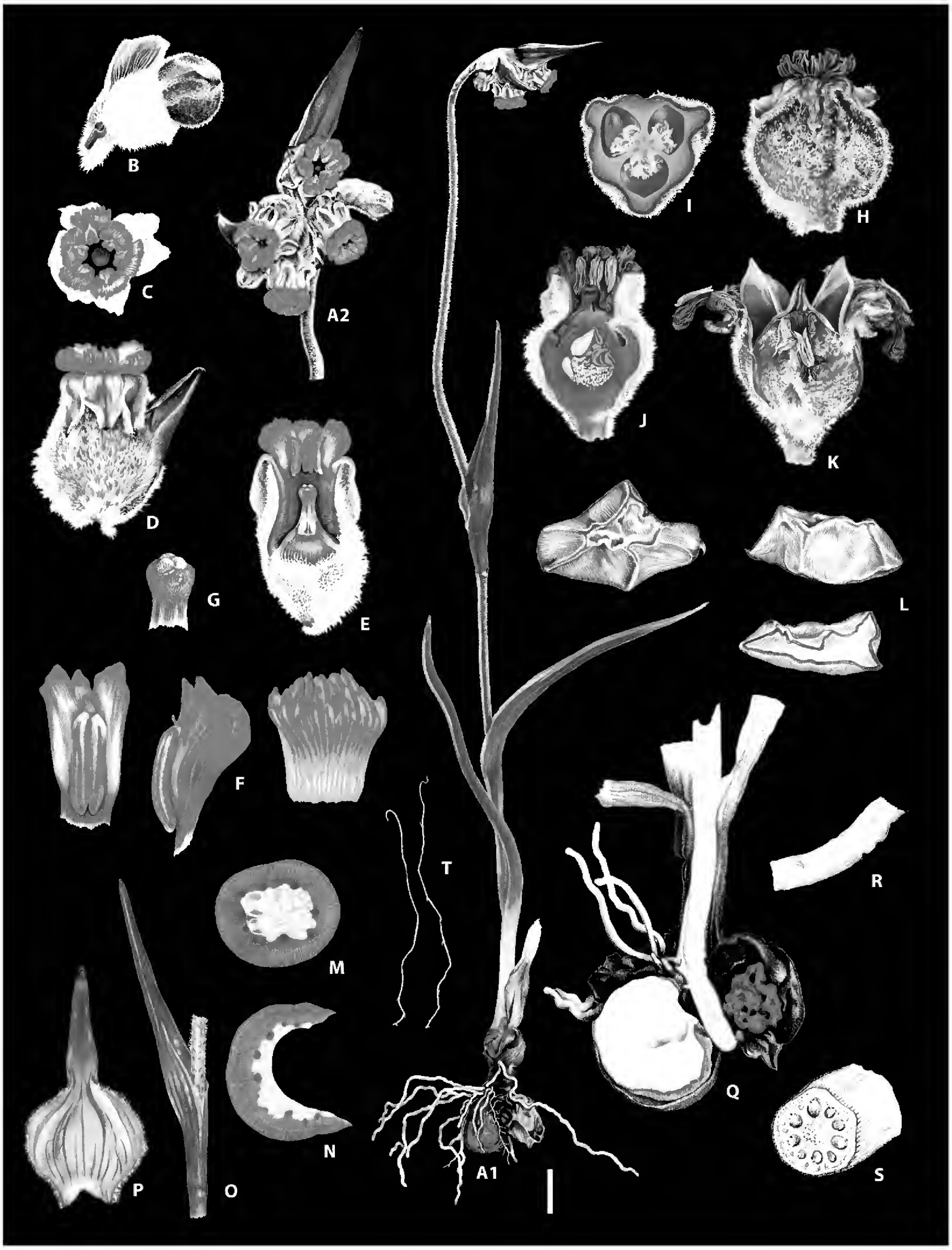

Figure 26. *Tribonanthes brachypetala*. A1 – whole plant; A2 – inflorescence; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, side and back view showing yellow fleshy stamen connective appendages exceeding anthers and yellow anthers with apex apiculate and projecting upwards; G – style short with three protuberances on stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 1 cm (A1); 5 mm (A2); 2.5 mm (B, C, D, E, H, I, J, K, P, R); 1 mm (F, G); 0.5 mm (L, S, T); 0.65 mm (M, N); 4 mm (O, Q). A– G & M– T drawn from fresh material at Millinup Road, Porongurup Range after a fire in 2010 (no voucher) and H– L drawn from *E.J. Hickman* 2022 (PERTH 08989370). Illustrations by E.J. Hickman.

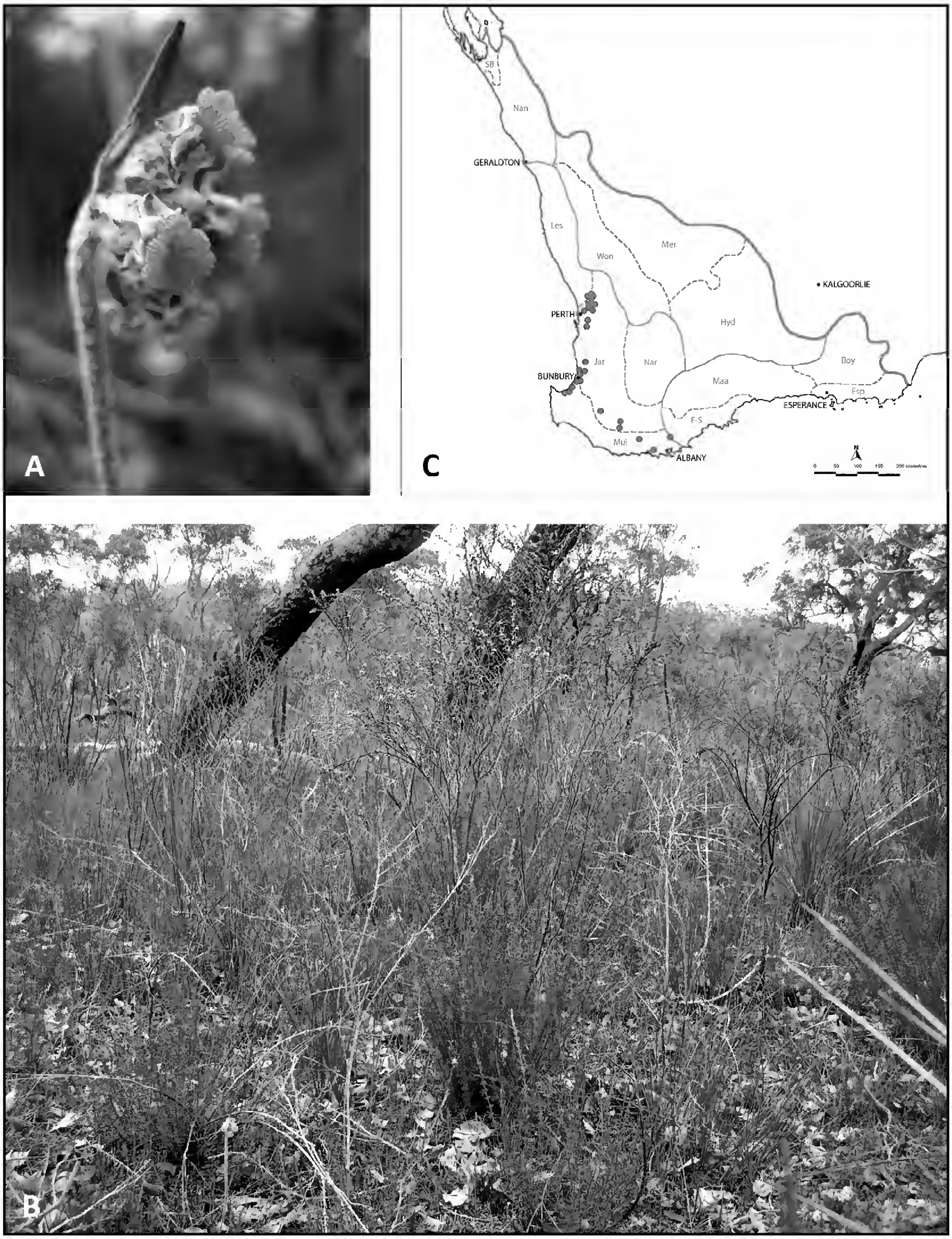

Figure 27. *Tribonanthes brachypetala*. A – plant showing multi-flowered inflorescence, with prominent yellow stamen connective appendages and reflexed perianth lobes (no voucher, Millinup Rd, Porongurup Range after a fire in 2010) B – habitat (no voucher, Millinup Rd, Porongurup Range after a fire in 2010), recently burnt open woodland of *Corymbia calophylla* and *Eucalyptus marginata* over *Taxandria parviceps, Astartea sp.* and *Cyathochaeta equitans* on grey brown loam over laterite at base of the southern slopes of the Porongurup Range, Western Australia; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Etymology. From the Greek *brachys* (short) and *petalon* (leaf, but in modern botany referring to petals).

Notes. *Tribonanthes brachypetala* is more readily observed in the flowering period following a burn of its habitat and is then found in diminishing numbers of plants in subsequent seasons for a few years after the burn. The exception is when the plants' habitat is open woodland of *Eucalyptus wandoo*, where the understorey is sparse, or on granite outcrops, when plants may flower in the absence of fire. The fruiting specimens examined show *T. brachypetala* displays early abortion of many ovules resulting in only a few seeds per capsule.

Tribonanthes Endl. subg. **Salina** E.J.Hickman & Hopper, *subg. nov.*

Type: *Tribonanthes minor* M.Lyons & Keighery

Aerial stem 1.3–4 cm tall. *Flowers* laterally horizontal, solitary. *Perianth* white to pale green with reflexed lobes. *Style* 0.5–1.5 mm long.

Etymology. From the Latin *salina* for salty, alluding to the general habitat occupied on the margins of salt lakes.

Notes. This monotypic subgenus is distinctive in its diminutive size, the smallest species known of Haemodoraceae.

11. Tribonanthes minor M.Lyons & Keighery, *Nuytsia* 16: 78 (2006).

Type: Chinocup Nature Reserve [precise locality withheld for conservation reasons], Western Australia, 18 October 2000, *M.N. Lyons* 2734 (*holo*: PERTH 07245890!).

Illustration. M. Lyons & G. Keighery, *Nuytsia* 16: 79, Figure 1 (2006).

Herb annually renewed from a white ovoid corm, 1.3–3.9 cm tall above ground, consisting of a single stem and single leaf. *Corms* 4–6 mm diameter, covered by numerous old brown, papery sheaths, 1.3–3.8 cm below soil surface. *Roots* white, with long fine root trichomes, some sand-binding rhizosheaths. *Aerial stem* (from basal leaf to inflorescence bract) 0.3–0.8 cm, glabrous. *Basal leaf* 1.3–3 cm long, spreading, stem-clasping to terete, deep red-purple, with a mucronate tip, glabrous. *Inflorescence bract* 0.5–0.9 cm long, funnel-like sheath with broad dilated mouth, red-purple, 2–4 mm circumference at widest point, with glabrous margin, lamina 0.2–1.5 mm long, terete, red-purple to green, with mucronate tip. *Peduncle* (from inflorescence bract to floral bract) 4.5–22 mm long, covered in white woolly trichomes. *Inflorescence* a solitary flower, subtended by a single floral bract. *Floral bract* 4–5.5 mm long, 3–5 mm wide, ovate, pinkish-purple, broad membranous margins, with a few fringing trichomes, otherwise glabrous inside and out, apex 0.5–1mm long terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 1.1–2 mm long, 0.8–1.2 mm wide, strongly reflexed, acute, outside surface white woolly hairy, inside surface pale green to purplish, glabrous. *Perianth tube* 2.6–3.5 mm long, outer surface covered in white woolly trichomes, inner surface pale green, glabrous. *Stamen connective appendages* relatively large, 0.7–1 mm long, 0.8–1 mm wide, fleshy, yellow, topped with 4 broad, round-tipped finger-like projections, extending above anther tips. *Anthers* 1–1.3 mm long, cream, with cream sterile apex that projects away from centre of flower, attached at base of stamen connective appendage. *Ovary* green, superior, 3 locules with several (10–12) ovules per locule. *Style* short to almost absent, 0.5–1.5 mm long, green. *Stigma* capitate, simple, yellow, covered with short

trichomes. *Capsule* greyish brown; perianth persistent; lobes reflexed before and after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 28, 29)

Diagnostic features. Small plant, terete leaf, long peduncles, solitary flowered inflorescence, strongly reflexed perianth lobes, obvious yellow stamen connective appendages, short to almost absent style with simple stigma, superior ovary.

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 4 Oct. 2007, *T. Erickson* 116 (PERTH); 28 July 2015, *E.J. Hickman* 2079 (PERTH); 28 July 2015, *E.J. Hickman* 2081 (PERTH); 12 Oct. 1988, *S.D. Hopper* 6931 (PERTH); 19 Oct. 1999, *M.N. Lyons* 2929 (PERTH); 24 Oct. 2000, *M.N. Lyons* 2735 (PERTH); 28 Aug. 2007, *R.J. Smith, S.D. Hopper & L. Sweedman* 059 (K, PERTH).

Proposed vernacular name. Salt-lake Tiurndin.

Phenology. Flowers July to August.

Distribution and habitat. *Tribonanthes minor* is known from scattered populations from the Meckering area south to the Lake King area. Populations are located in the Wongan District of the Transitional Rainfall Province and Maalak District of the Southeast Coastal Province of south-west Western Australia (Gioia & Hopper 2017). It grows on seasonally wet, low sandy rises on the the margins of naturally saline lakes. The vegetation is heath, scrub and samphire flats, associated species include, *Melaleuca thyoides*, *Atriplex hymenotheca*, *Tecticornia indica*, *T. halocnemoides*, *T. leptoclada*, *Roycea spinescens*, *Samolus caespitosus*, *Tecticornia moniliformis*, *Gnephosis acicularis*, *G. tridens*, *Hyalochlamys globifera* and a variety of annual herbs (Figure 29).

Conservation status. Currently listed as Priority Three under Conservation Codes for Western Australian Flora (Smith & Jones 2018). Due to its preference for low elevations on the margins of naturally saline lakes *T. minor* is under threat from increased risk of flooding associated with changes in catchment hydrology following agricultural clearing (Lyons & Keighery 2006; Smith & Jones 2018).

Etymology. From the Latin *minor* (smaller), referring to the very small leaves, stems, flowers and perianth lobes of this species.

Notes. *Tribonanthes minor* is presently known from three or four locations, with herbarium specimens collected from all but the Lake Goorly location. Its presence at Lake Goorly was recorded in quadrats for the Salinity Action Plan survey (Keighery 2004) across the state of Western Australia in 1999 (M. Lyons *pers. comm.*, 13 September 2013), but is thought to be dubious. Field visits to Lake Goorly by N. Gibson in October 2013 (N. Gibson *pers. comm.* 22 October 2013), EJH in July 2015 and SDH in September 2017 failed to locate any specimens. Lake Goorly is not shown on the map (Figure 29C).

Tribonanthes Endl. subg. **Boya** E.J.Hickman & Hopper, *subg. nov.*

Type: *Tribonanthes purpurea* T.Macfarlane & Hopper.

Aerial stem 1.1–4.3 cm tall. *Flowers* erect, solitary. *Perianth* pink with erect lobes. *Style* 4.0–7.0 mm long.

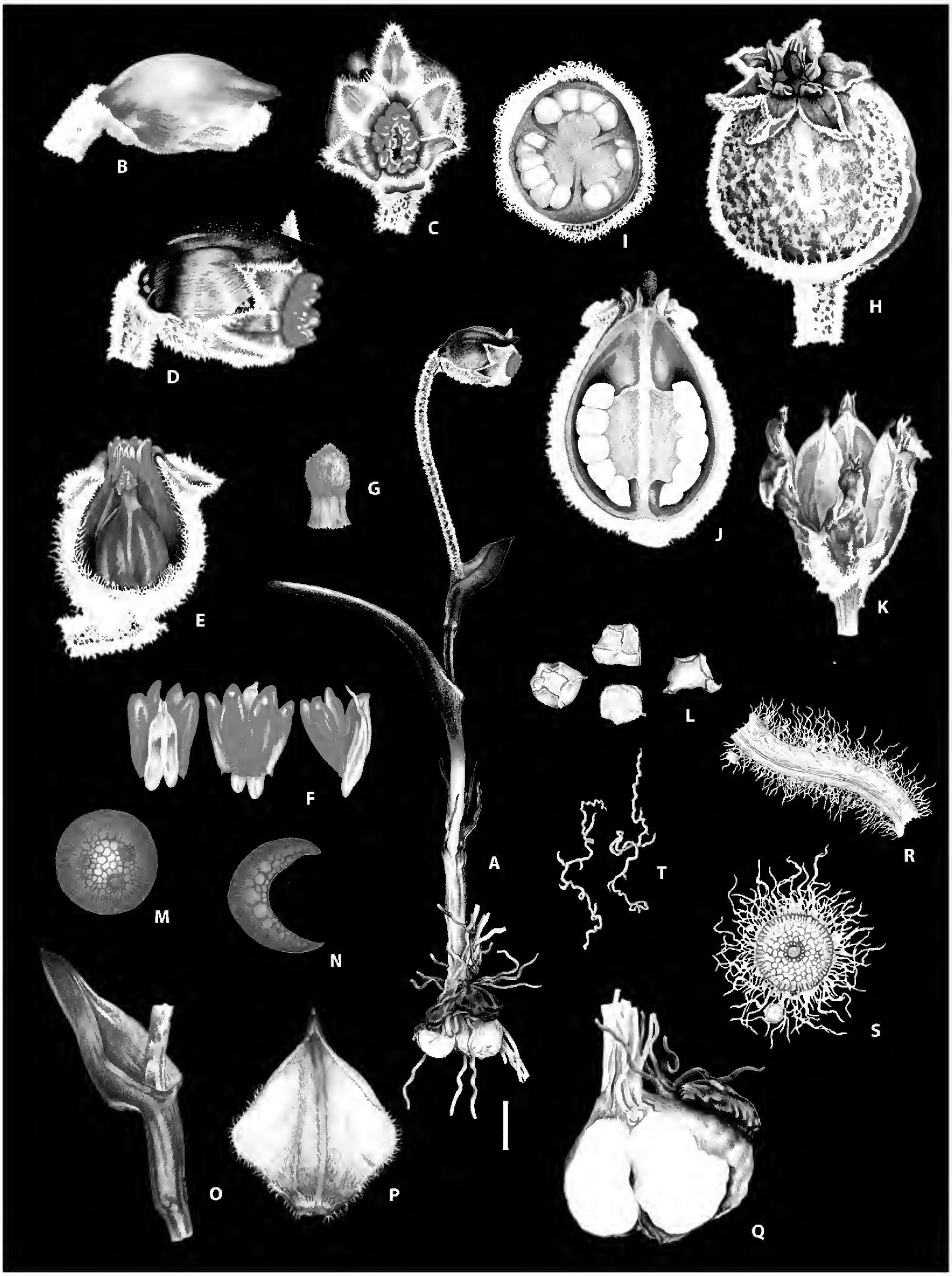

Figure 28. *Tribonanthes minor*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and style; F – stamens from front, back and side view showing yellow fleshy, stamen connective appendages exceeding anthers and cream anthers with apex apiculate and projecting upwards; G – style sub-sessile with simple stigma; H – capsule; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth trichomes. Scale bars = 2.5 mm (A); 1 mm (B, C, D, E, H, I, J, K, O, P); 0.5 mm (F, G, M, N, R, T); 0.4 mm (L); 2 mm (Q); 0.2 mm (S). Drawn from fresh material *E.J. Hickman* 2079 (PERTH 08989427). Illustrations by E.J. Hickman.

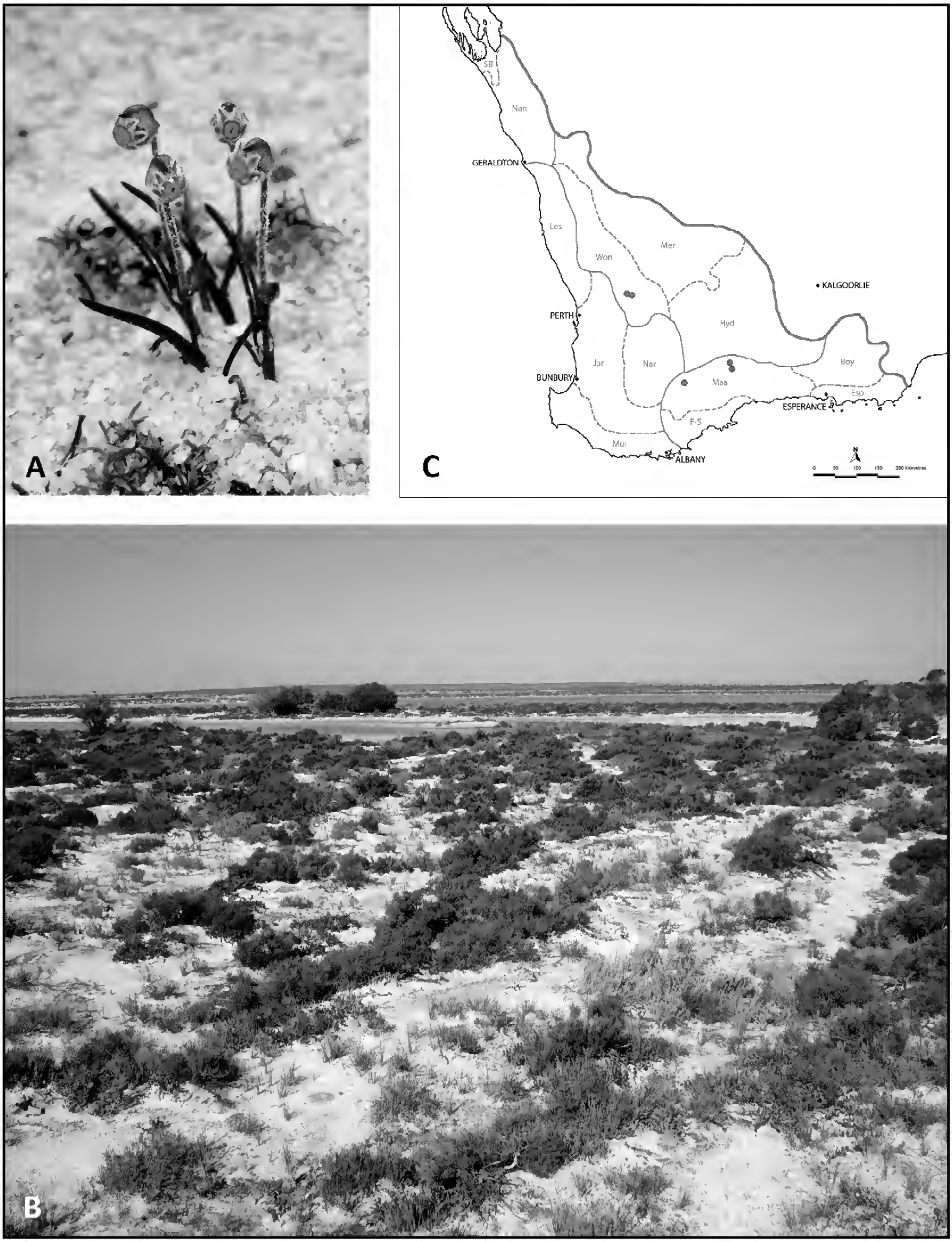

Figure 29. *Tribonanthes minor*. A – group of plants each with a single-flowered inflorescence with obvious yellow stamen connective appendages and strongly reflexed perianth lobes (*E.J. Hickman* 2079); B – habitat of *T. minor* (*E.J. Hickman* 2081), samphire on low sandy rises; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Etymology. From the Noongar word *boya* for granite rock or stone, as a noun in apposition, alluding to the habitat occupied by the sole species.

Notes. A monotypic subgenus distinctive in its almost stemless pink erect tubular flowers.

12. Tribonanthes purpurea T.Macfarlane & Hopper, *Fl. Australia* 45: 465 (1987).

Type: near Kuender [precise locality withheld for conservation reasons], Western Australia, 27 August 1986, *S.D. Hopper* 5237 (*holo*: PERTH 01008625!; *iso*: CANB. 00394484 image!).

Illustrations. T.D. Macfarlane, *Fl. Australia* 45: 135, Figure 52 R-U (1987); S.D. Hopper, S. van Leeuwen, A.P. Brown & S.J. Patrick, *WA Endemic Flora* p. 79 (1990); A. Brown, C. Thomson-Dans & N. Marchant, *WA Threatened Flora* p. 167 (1998).

Herb annually renewed from a white ovoid corm, 1.1–4.3 cm tall, consisting of a single stem and single leaf. *Corms* 5–6 mm diameter, covered by numerous old brown, papery sheaths, 1–4.6 cm below surface. *Roots* white, with long fine root trichomes, lacking a sand-binding rhizosheath. *Aerial stem* (from basal leaf to inflorescence bract) 0.1–2.2 cm, glabrous. *Basal leaf* 2–5.4 cm long, spreading, stem-clasping base, becoming terete, the base white grading to green, with darker mucronate tip, glabrous. *Inflorescence bract* 9–20 mm long, erect, funnel-like sheath with broad dilated mouth, 6–12 mm circumference at widest point, purplish green with broad pinkish purple membranous margins, glabrous; lamina 2–10 mm long, terete, green with a mucronate tip. *Peduncle* (from inflorescence bract to floral bract) absent, or if present to 0.2 cm long, glabrous. *Inflorescence* a solitary flower, often appearing geoflorous, subtended by the inflorescence bract and a floral bract. *Floral bract* 6–13 mm long,4–10 mm wide, ovate, green with broad pinkish purple membranous margins, inside and outside surfaces glabrous, apex 1–4 mm long, terete, ending in a darker tip, not exceeding perianth lobes. *Perianth lobes* 4–6.1 mm long, 1.6–3 mm wide, erect, oblong, pink, glabrous inside and outside, outer lobes with reddish-purple gland-like protuberances at apex. *Perianth tube* 4.6–7 mm long, white, glabrous inside and outside. *Stamen connective appendages* scarcely developed, 2–3 white projections, much shorter than anther tips. *Anthers* 1–2 mm long, yellow, with cream sterile apex that projects upwards, attached towards top of stamen connective appendage. *Ovary* green, superior, 3 locules with few (7) ovules per locule. *Style* long, 4.0–7.0 mm, green. *Stigma* capitate, simple, yellow, with a few short trichomes on top. *Capsule* greyish brown; perianth persistent; lobes erect before dehiscence, upwardly spreading after dehiscence. *Seeds* purplish grey-brown, angular. (Figures 30, 31)

Diagnostic features. Small plant, terete leaf, peduncles absent or rudimentary, solitary flowered inflorescence, pink glabrous flowers often appearing geoflorus, stamen connective appendages scarcely developed, superior ovary, long style with simple stigma.

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 29 Aug. 1994, *A.M. Coates* 4312 (PERTH); 31 July 1999, *V. Crowley s.n.* (PERTH); 12 Sep. 1995, *R. Cugley* 7 (PERTH); 23 Aug. 2004, *R. Cugley* 159 (PERTH); 22 Aug. 1990, *D. Davidson s.n.* (PERTH); 28 July 2015, *E.J. Hickman* 2080 (PERTH); 29 July 2015, *E.J. Hickman* 2082 (PERTH); 1 Aug. 2015, *E.J. Hickman* 2083 (PERTH); 1 Aug. 2004, *G.J. & B.J. Keighery* 270 (PERTH); 2 Sep. 2011, *D. Sandow et al.* DSA 07 (PERTH).

Proposed vernacular name. Granite Pink (proposed by Hopper *et al.* 1990).

Phenology. Flowers from July to September.

Distribution and habitat. *Tribonanthes purpurea* is known from the Mt Dale area in the Darling Range to the Porongurup Range and east to Varley. Populations are located within the Jarrah and Narrogin Districts of the Bibbulmun Province, the Hyden District of the Transitional Rainfall Province and the Maalak and Fitzgerald-Stirling Districts of the Southeast Coastal Province of south-west Western Australia (Gioia & Hopper 2017). *Tribonanthes purpurea* mostly grows on brown sandy loam associated with granite outcrops but has also been found growing on grey sandy clays of winter wet flats. These habitats support moss swards, herbfields, heath and shrublands with associated species including *Thryptomene australis*, *Borya constricta*, *Dodonaea viscosa*, *Melaleuca elliptica*, *M. viminea*, *M. uncinata*, *Acacia lasiocalyx*, *Spartochloa scirpoidea*, *Stypandra glauca*, *Drosera* spp., *Stylidium* spp., *Caladenia* spp. and *Wurmbea* spp. (Figure 31).

Conservation status. Threatened Flora protected under the *Biodiversity Conservation Act 2016* with a ranking of Vulnerable. Due to its small stature, succulent leaves and occurrence on open herbfields, it is under threat from grazing by rabbits (Brown *et al*. 1998; Smith & Jones 2018). Its ability to regenerate after grazing is unknown.

Etymology. Specific name from the Latin *purpureus* meaning purple, or red with a touch of blue, referring to the pink perianth lobes of this species.

Notes. *Tribonanthes purpurea* is the most distinctive species of the genus with its glabrous pink flowers. Presently it is known from 14 populations, several of which have sub-populations within the same granite outcrop complex. However, the senior author has revisited several of these populations over the last five years and not relocated the plants at three locations – Beaufort River, Porongurup Range and north of the Stirling Range. Neither author has visited the Hillman location.

Natural hybrids

A small number of natural hybrid combinations of *Tribonanthes* have been recorded in herbarium collections at PERTH. Apart from morphological intermediacy and comparative rarity in populations of abundant likely parents, evidence in favour of the occurrence of natural hybridization is cited on the label of one specimen where pollen fertility was reduced to 62% in the putative hybrid of *T. australis* × ? *violacea* (*S.D. Hopper* 5776).

Tribonanthes australis Endl. × **brachypetala** Lindl.

Specimens examined. WESTERN AUSTRALIA: Brixton Road, Beckenham, 13 Aug. 1983, *G.J. Keighery* 6249 (PERTH); airport, 6 km SE Bunbury to Boyanup, 19 Sep. 1983, *G.J. Keighery* 6427 (PERTH); 9 km along Railway Rd, Boyanup to Capel, 29 Aug. 1984, *G.J. Keighery* 6828 (PERTH); Ambergate Regional Park, S of Busselton, 13 Sep. 1994, *G.J. Keighery* 13399 (PERTH); Yoongarillup Townsite Reserve, SE of Busselton, 15 Sep. 2006, *G.J. Keighery* 17029 (PERTH).

Tribonanthes australis Endl. × **longipetala** Lindl.

Specimens examined. WESTERN AUSTRALIA: Brixton Rd, Beckenham, Perth, 21 Aug. 1983, *G.J. Keighery* 6260 (PERTH); Pinjarra Nature Reserve, Pinjarra, 30 Aug. 2007, *G.J. Keighery* 17133 (PERTH).

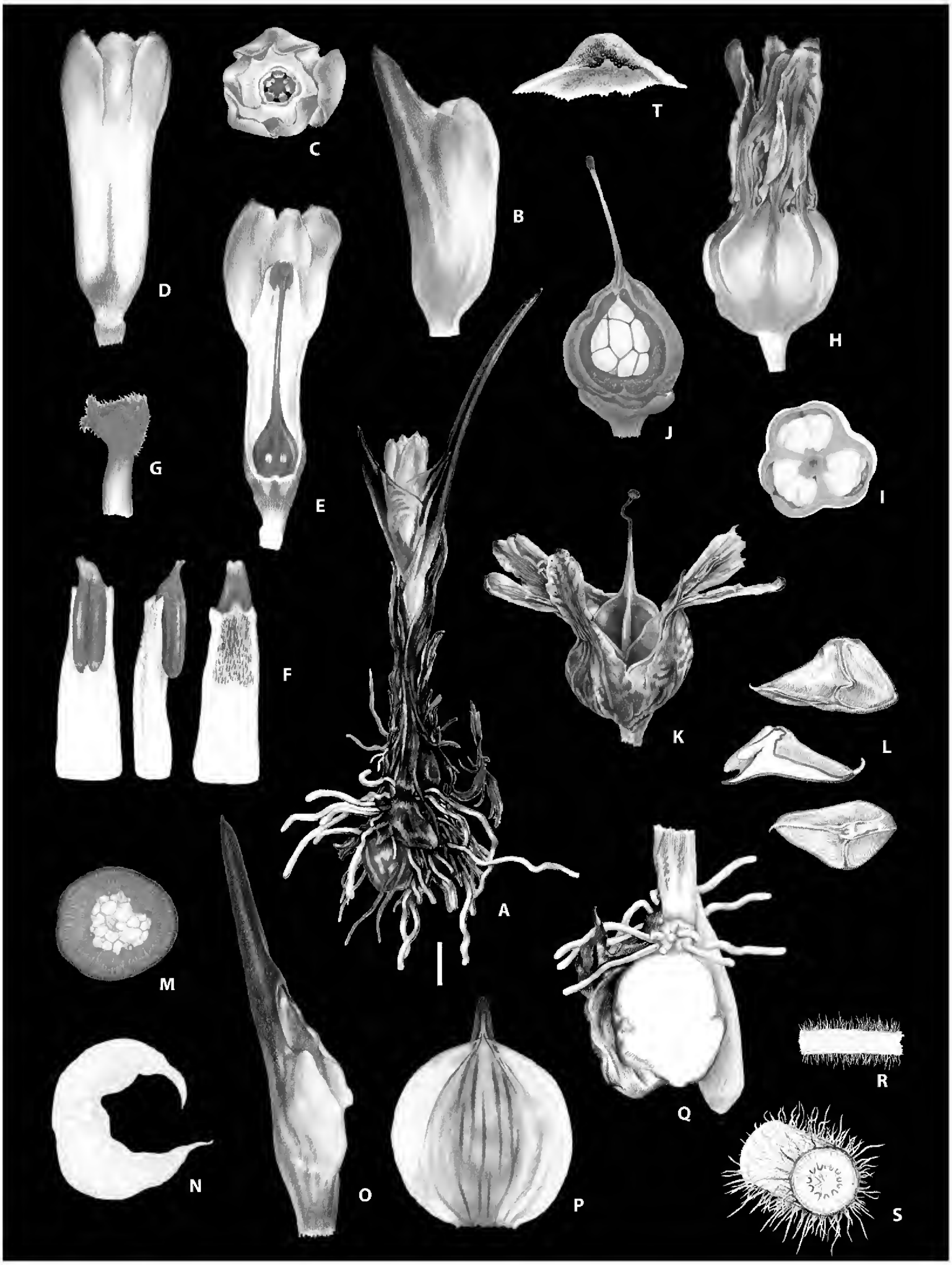

Figure 30. *Tribonanthes purpurea*. A – whole plant; B – bud; C – flower from top; D – flower from side; E – flower with part of perianth removed to show ovary and elongated style; F – stamens from front, side and back view showing stamen connective appendages scarcely developed, translucent, surface punctate, much shorter than anthers and yellow anthers with apex apiculate and projecting upwards; G – style tip with capitate stigma; H – capsule, glabrous; I – cross section of capsule; J – longitudinal section of capsule; K – dehisced capsule; L – seeds; M – leaf section near apex; N – leaf section near base; O – inflorescence bract; P – floral bract; Q – longitudinal section of corm; R – root; S – cross section of root; T – detail of perianth tip. Scale bars = 4 mm (A); 1.5 mm (B, C, D, E, H, I, J, K); 0.5 mm (F, G, L, M, N); 2 mm (O, P, Q); 1 mm (R); 0.4 mm (S, T). Drawn from fresh material *E.J. Hickman* 2083 (PERTH 08989443). Illustrations by E.J. Hickman.

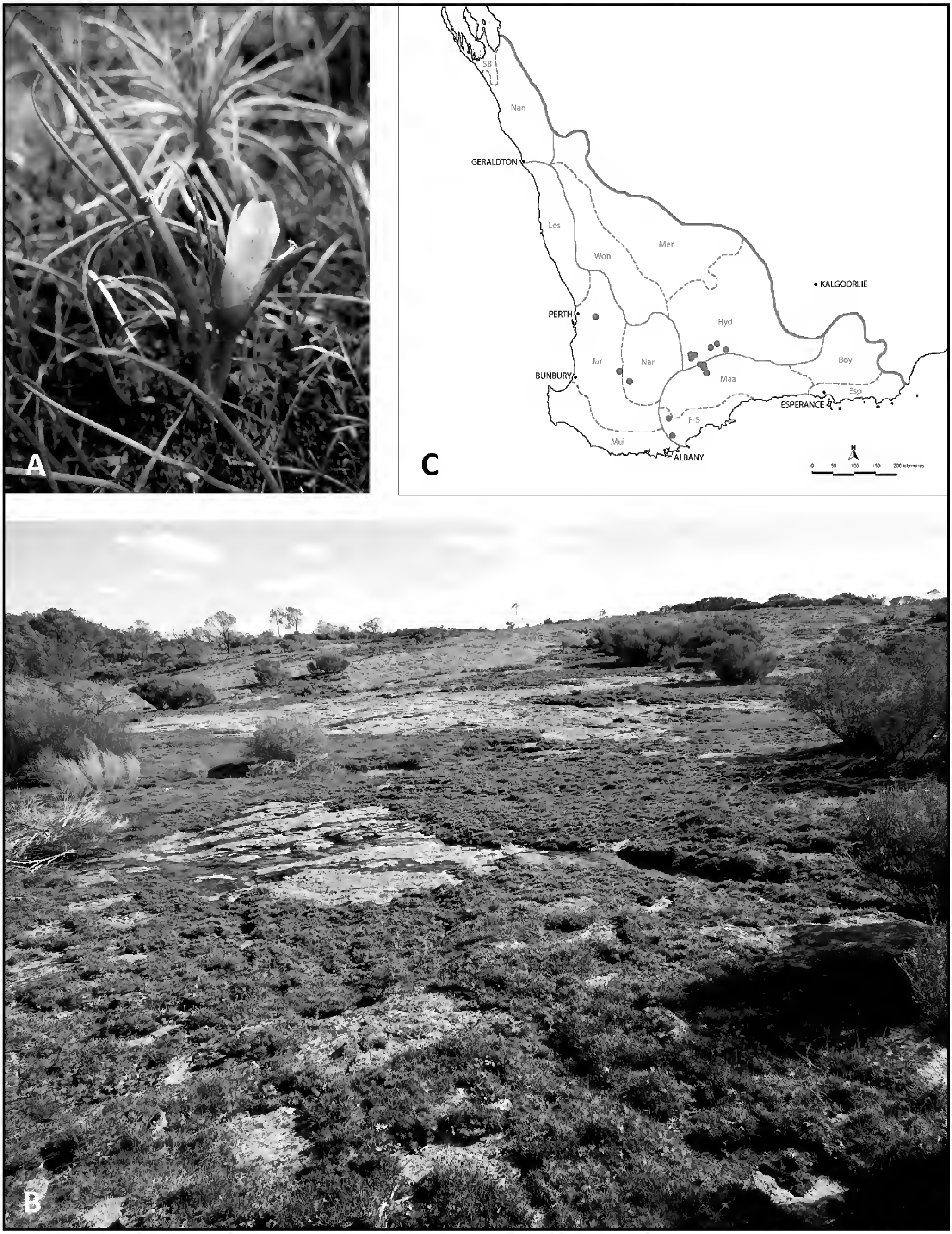

Figure 31. *Tribonanthes purpurea*. A – single-flowered inflorescence with pink, glabrous, erect perianth lobes, (*E.J. Hickman* 2080); B – habitat of *T. purpurea* (*E.J. Hickman* 2080), *Borya* herbfield and moss swards in shallow soil pockets between granite sheets; C – distribution (abbreviations for floristic provinces and districts as in Figure 9). Photos by E.J. Hickman.

Tribonanthes australis Endl. × ?**violacea** Endl.

Specimen examined. WESTERN AUSTRALIA: 12.6 km off Unicup Rd along Wingebellup Rd, ESE to Unicup Lake, 16 Oct. 1986, *S.D. Hopper* 5776 (PERTH).

Tribonanthes variabilis Lindl. × **brachypetala** Lindl.

Specimen examined. WESTERN AUSTRALIA: Brixton Street Wetlands, Kenwick, 24 Aug. 2010, *K.L. Brown & G. Paczkowska* KLB 854 (PERTH).

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A taxonomic review of the *Styphelia xerophylla* group (Ericaceae: Epacridoideae: Styphelieae)

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Abstract

Hislop, M. & Puente-Lelièvre, C. A taxonomic review of the *Styphelia xerophylla* group (Ericaceae: Epacridoideae: Styphelieae). *Nuytsia* 30: 155–175 (2019). Species belonging to the Western Australian *S. xerophylla* (DC.) F.Muell. group (or Group IX) are described and illustrated. The treatment includes two species published in the nineteenth century, *S. xerophylla* and *S. stomarrhena* (Sond.) Sleumer, together with four new species, *S. angustiflora* Hislop & Puente-Lel., *S. cernua* Hislop & Puente-Lel., *S. disjuncta* Hislop & Puente-Lel. and *S. sulcata* Hislop & Puente-Lel. A seventh member of the group, *S. longissima* Hislop & Puente-Lel., was described in a recent paper and is not treated again here. The morphological attributes of the group are outlined and a key to species provided.

Introduction

The *Styphelia xerophylla* (DC.) F.Muell. group (or Group IX) is one of 12 phylogenetic groups resolved within the large *Styphelia* Sm.–*Astroloma* R.Br. clade of tribe *Styphelieae* Bartl., as a result of recent molecular research (Puente-Lelièvre *et al.* 2016). Although these lineages were generally well-supported by the molecular data, not all of them could be diagnosed by unique morphological characters or character combinations. This led the researchers to adopt a conservative approach and accept a broad circumscription for *Styphelia*, inclusive of all 12 groups. As a result, the genera *Astroloma*, *Coleanthera* Stschegl. and *Croninia* J.M.Powell, together with a large number of the taxa previously included in *Leucopogon* R.Br., have now been subsumed into *Styphelia* (Crayn *et al.* 2019).

The *Styphelia xerophylla* group comprises seven species and is thought to be exclusively Western Australian. Morphological assessment suggests that it is unlikely that other western or eastern Australian taxa, not included in previous molecular analyses, belong to this group. The earliest named species in the group, *S. xerophylla* and *S. stomarrhena* (Sond.) Sleumer, are also the most widespread, both having geographical ranges encompassing more than one bioregion. The other five have very restricted, sometimes disjunct, distributions in the Geraldton Sandplains, Jarrah Forest and Mallee bioregions. All five are of conservation concern, including two that have already been assessed as Threatened Flora (Smith & Jones 2018). One of these threatened species, *Styphelia longissima* Hislop & Puente-Lel., has only recently been described (Hislop & Puente-Lelièvre 2017) and is not treated again here.

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The phylogenetic tree topology obtained by Puente-Lelièvre *et al.* (2016) indicates that the closest relative of the *S. xerophylla* group is the *S. conostephioides* (DC.) F.Muell. group (or Group VIII). Together the two groups are sister to Groups I–VII, which collectively encompass a large proportion of all *Styphelia* species.

This paper is the first in a series detailing the morphological attributes of these groups and providing descriptions of their member species. Some of the groups comprise at least as many undescribed as described taxa, and a significant number of these are of conservation concern. A formal infrageneric classification will be published once the relationships of a number of mostly eastern Australian species are resolved. Further consideration of the best way to classify the morphologically heterogeneous Group X (*sensu* Puente-Lelièvre *et al.* 2016) is also required.

Methods

This study was based on an examination of dried specimens housed at PERTH, together with field observations of the species described and their relatives in Western Australia.

Foliar measurements and observations were taken from dried specimens in natural posture. Care was taken to confine observations to mature leaves. Inflorescence length was measured from the point of attachment at the axil to the tip of the bud-rudiment. Floral measurements were taken from rehydrated flowers in natural posture, with the exception of the corolla lobes which were uncurled to their fullest length before measuring. Fruit length is inclusive of a gynophore, if present.

Bioregions referred to in the text and shown on distribution maps follow *Interim Biogeographic Regionalisation for Australia* (IBRA) v. 7 (Department of the Environment 2013).

The *Styphelia xerophylla* group

Morphological synopsis

Leaves helically arranged; apex long-mucronate, pungent, although sometimes the mucro rather delicate and brittle; lamina adaxially concave; abaxial surface smooth to variously grooved, glabrous or variously hairy. *Inflorescence* 1- or occasionally 2-flowered; axis erect (widely spreading to ± pendulous in *S. cernua* Hislop & Puente-Lel.), extending above floral node, or upper node if more than one flower is present, and terminating in a bud-rudiment; distal portion of axis, above the floral node, distinctly flattened, usually bract-like and often lobed on either side of the bud-rudiment; basal portion of axis, below the floral node with 4–5 sterile bracts, the lowest two opposite. *Bracteoles* conspicuously striate when dry, not keeled. *Sepals* usually conspicuously striate when dry (sometimes only faintly so in *S. xerophylla*), usually equal to, or longer than, the corolla tubes (always shorter in *S. stomarrhena*, occasionally shorter in *S. xerophylla*). *Corolla* usually white (red in *S. stomarrhena*). *Corolla tube* internal surface hairy in the upper part below the lobes, basal hair tufts usually absent (present only in *S. stomarrhena*), external surface usually glabrous (hairy in *S. sulcata* Hislop & Puente-Lel.). *Corolla lobes* mostly erect in the basal 1/4–1/2 and then spreading and recurved above; outer surface glabrous or hairy (in *S. stomarrhena* and *S. sulcata*), inner surface usually densely hairy (sparsely and unevenly hairy in *S. stomarrhena*) with twisted, distinctly ornamented hairs. *Anthers* usually partially exserted from corolla tube and free from each other (fully exserted and cohering in *S. stomarrhena*). *Filaments* usually terete (plano-convex in *S. stomarrhena*), attached 1/2–3/4 above anther base (attached just below anther apex in *S. stomarrhena*), adnate to the corolla tube just below the sinuses. *Ovary* usually

glabrous (hairy in *S. longissima*), 2–5-locular, pale to mid green in dried material. *Nectary* annular, truncate to variously lobed. *Style* usually scabrous or very shortly hairy, at least in the upper half (may be glabrous in *S. stomarrhena*), well exserted from the corolla tube in most species, with the stigma held at about the same level as the erect bases of the corolla lobes (greatly exserted in *S. stomarrhena* with the stigma held well beyond the erect corolla lobe bases); style base arising directly from ovary apex, not inset in a cylindrical depression and enveloped by ovarian tissue. *Drupe* variously shaped, longer or shorter than the calyx, circular in section, apex obtuse; mesocarp well-developed in most species (poorly developed and a gynophore present in *S. sulcata*).

Important distinguishing features

The relatively large, striate bracteoles and sepals found in the species of Group IX are an important diagnostic feature. Among the western groups only Group I (the *Astroloma s. str.* species group) and the species-pair, *S. crassiflora* F.Muell. and *Leucopogon* sp. Badgingarra (R. Davis 421) from Group X, have similarly large and striate bracteoles and sepals.

Members of Group IX can be distinguished from those of Group I by their white flowers (*cf.* red, orange, green or cream-coloured), in having corolla tubes that lack basal hair tufts (*cf.* basal hair tufts usually present), terete filaments (*cf.* usually distinctly flattened, sometimes compressed only) and corolla lobes of uniform texture (rather than bitextured). *Styphelia stomarrhena* is aberrant in regard to all except the last of these features. It is however easily recognised by its long-exserted anthers and hairy filaments. Its remarkable morphology is discussed below under the description of that species.

From *S. crassiflora* and *L.* sp. Badgingarra, members of Group IX differ in having internal corolla tubes that are hairy in the upper part below the lobes (*cf.* glabrous in this area), corolla lobe hairs twisted and strongly ornamented (*cf.* straight and not or barely ornamented), and flat (rather than undulate) sepal margins.

The sepal length alone is useful in recognising members of Group IX. Very few western *Styphelia* outside of Group I have sepals longer than those of *S. disjuncta* Hislop & Puente-Lel. (i.e. 4.2–5.3 mm long), the smallest flowered member of Group IX. Species other than those from Group I that may occasionally have longer sepals belong to the *S. conostephioides* group. Members of the latter group however can be readily distinguished from those of Group IX in always having partite nectaries (*cf.* annular in Group IX), usually pendulous inflorescences (*cf.* erect apart from *S. cernua*) and usually hairy ovaries (*cf.* glabrous apart from *S. longissima*).

Distribution

The seven species that constitute Group IX are mainly distributed in near west coastal districts (within about 60 km of the coast) from the Kalbarri area to a little south of Perth and then with disjunct occurrences south and east as far as the Condingup area, east of Esperance. The Geraldton Sandplains bioregion is the main centre of distribution with four species.

Key to species

1. Corolla red; anthers cohering, long-exserted from corolla tube on hairy filaments (Eneabba–eastern Perth suburbs) .... **S. stomarrhena**

1: Corolla white; anthers free, partially included within corolla tube, filaments glabrous

2. Inflorescence axis widely spreading to ± pendulous, 3.4–5.2 mm long; drupe ellipsoid, at least as long as the sepals (Kalbarri area) .... **S. cernua**

2: Inflorescence axis erect, 1.5–3.6 mm long (usually < 3 mm); drupe variously shaped but not ellipsoid, always much shorter than the sepals

3. Ovary densely hairy; at least some leaf margins densely long-ciliate with hairs 0.5–1.0 mm long (Eneabba area).. **S. longissima**

3: Ovary glabrous; leaf margins glabrous, minutely ciliolate or irregularly ciliate with hairs < 0.5 mm long

4. Leaf abaxial surfaces narrowly and deeply grooved, densely hairy in the grooves; ovary 2-locular; drupe cylindrical, gynophore present (Cascades area and NE of Condingup) .... **S. sulcata**

4: Leaf abaxial surfaces broadly and shallowly grooved, glabrous or sometimes sparsely and evenly hairy; ovary 3–5-locular; drupe obovoid, depressed-obovoid or globose, gynophore absent

5. Sepals 4.2–5.3 mm long; corolla tube 3.4–4.2 mm long; drupe obovoid (Dumbleyung and Ongerup areas) .... **S. disjuncta**

5: Sepals 6.5–9.2 mm long; corolla tube 6.0–8.2 mm long; drupe depressed-obovoid or ± globose

6. Style base abruptly differentiated from ovary apex; drupe depressed-obovoid (eastern Darling Range)... **S. angustiflora**

6: Style base smoothly attenuated from ovary apex, such that it is difficult to tell where ovary ends and style begins; drupe ± globose or occasionally ovoid (Mount Adams–Watheroo–southern Perth suburbs.. **S. xerophylla**

Taxonomy

Styphelia angustiflora Hislop & Puente-Lel., *sp. nov.*

Typus: south-west of York [precise locality withheld for conservation reasons], Western Australia, September 1997, *J.L. Robson* 657 (*holo*: PERTH 04832353; *iso*: CANB, K, MEL, NSW).

Astroloma sp. sessile leaf (J.L. Robson 657), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 235 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au [accessed 21 February 2019].

Erect, compact *shrubs* to *c*. 80 cm high and 100 cm wide; fire-tolerance of rootstock unknown. Young *branchlets* with a moderately dense to dense indumentum of retrorse hairs, 0.05–0.20 mm long. *Leaves* spirally arranged, steeply antrorse to antrorse-appressed; apex long-mucronate, pungent, the mucro fine and rather brittle, 1.0–2.0 mm long; base obtuse to rounded; petiole well-defined, 0.3–0.6 mm long; lamina narrowly ovate to narrowly ovate-elliptic, 5.0–12 mm long, 1.3–3.0 mm wide, strongly concave adaxially, longitudinal axis gently incurved; surfaces discolorous, shiny; adaxial surface glabrous or with a few hairs towards the base, venation not evident; abaxial surface glabrous, paler, smooth, or shallowly grooved with 7–9 slightly raised primary veins and broad grooves between; the margins narrowly hyaline, at least towards the base, mostly glabrous or occasionally irregularly ciliate. *Inflorescence* axillary, erect; axis 2.5–3.5 mm long, 1(2)-flowered, ± terete in lower portion, flat and bract-like above the fertile node and terminating in a bud rudiment, sparsely hairy on the terete portion with a moderately dense indumentum on all surfaces of the flat portion; flowers sessile.

Fertile bracts broadly ovate to ± orbicular, 1.4–2.0 mm long, 1.4–1.7 mm wide, subtended by 4 or 5 smaller, sterile bracts. *Bracteoles* ovate to elliptic, 2.6–3.7 mm long, 1.7–2.5 mm wide, obtuse with a very short sub-terminal mucro; abaxial surface striate, not keeled, shortly hairy, straw-coloured to pale brown when dry; margins ciliolate. *Sepals* narrowly elliptic or narrowly elliptic-obovate, 6.5–9.2 mm long, 1.8–2.5 mm wide, acute and mucronate; abaxial surface striate, glabrous or with a very short, sparse indumentum towards the apex, straw-coloured when dry; adaxial surface with a well-defined patch of hairs towards the base and scattered, shorter hairs above; margins ciliate, the hairs to 0.2 mm long, the longer ones concentrated towards the base and apex. *Corolla tube* white, narrowly obovoid to ± cylindrical, shorter than the sepals, 6.2–7.8 mm long, 2.8–3.1 mm wide, glabrous externally, internal surface with hairs extending to a point well below the anther bases. *Corolla lobes* white, shorter than the tube, 5.0–5.7 mm long, 1.4–1.7 mm wide at base, erect for 1/3–1/2 of their length and then spreading and recurved; external surface glabrous, internal surface with a dense indumentum of twisted and ornamented hairs. *Filaments* terete, glabrous, 0.3–0.5 mm long, attached to anther *c.* 2/3 above the base, adnate to tube just below the sinuses. *Anthers* partially exserted from the tube (by 1/3–1/2 of their length), 2.2–3.4 mm long, apex shallowly emarginate. *Nectary* annular, 0.4–0.7 mm long, shallowly lobed, glabrous. *Ovary* mid-green, globose or depressed-globose, 1.2–1.4 mm long, 1.2–1.4 mm wide, glabrous, deeply rugose, 3–5-locular. *Style* scabrous throughout, 6.5–9.7 mm long, abruptly differentiated from ovary apex, exserted from corolla tube with the stigma held at *c.* the level of the erect bases of the corolla lobes; stigma slightly expanded. *Fruit* depressed-obovoid, 2.3–2.5 mm long, 3.2–3.5 mm wide, much shorter than the calyx, shallowly rugose towards the apex, with 3–5 broad longitudinal ribs demarcating the suture lines on the endocarp; the apical surface ± flat, scarcely descending towards the style base; gynophore absent. (Figure 1)

Diagnostic characters. Within the *S. xerophylla* group, *S. angustiflora* is distinguished by the following character combination: leaf abaxial surfaces ± smooth to shallowly and broadly grooved; ovary glabrous, 3–5-locular; style abruptly differentiated from the ovary apex; fruit depressed-obovoid.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 1 Oct. 1997, *R. Davis* 4220 (PERTH); 22 Aug. 1999, *F. Hort* 543 (PERTH); 20 Sep. 1999, *F. & J. Hort* 697 (CANB, NSW, PERTH); 16 Dec. 1999, *F. Hort* 862 (PERTH); 7 Aug. 2000, *F. Hort* 1105 (PERTH); 7 Sep. 2000, *F. Hort* 1106 (CANB, NSW, PERTH); 16 Oct. 1987, *J.L. Robson* JLR 12 (PERTH); 11 Sep. 1999, *L.W. Sage, F. Hort & J. Hort* LWS 1565 (CANB, MEL, NSW, PERTH).

Distribution and habitat. Known only from a small area of the eastern Darling Range, south-west of York, in the Jarrah Forest bioregion, where it occurs on sandy flats in the understorey of Jarrah and *Banksia* woodland. Commonly associated species include *Banksia attenuata*, *B. menziesii*, *Adenanthos cygnorum*, *Allocasuarina humilis* and *Leptospermum erubescens*.

Phenology. Peak flowering is between August and early October. The only specimen with mature fruit present was collected in mid-December.

Etymology. From the Latin *angustus* (narrow) and *-florus* (-flowered), a reference to the noticeably narrower flowers of this species relative to those of *S. xerophylla*, to which it otherwise bears a similarity in gross morphology.

Conservation status. Listed as Priority Two (Smith & Jones 2018) under Conservation Codes for Western Australian Flora under the name *Astroloma* sp. sessile leaf (J.L. Robson 657). It is known from very few populations, all of which are within the boundaries of Wandoo National Park. On the

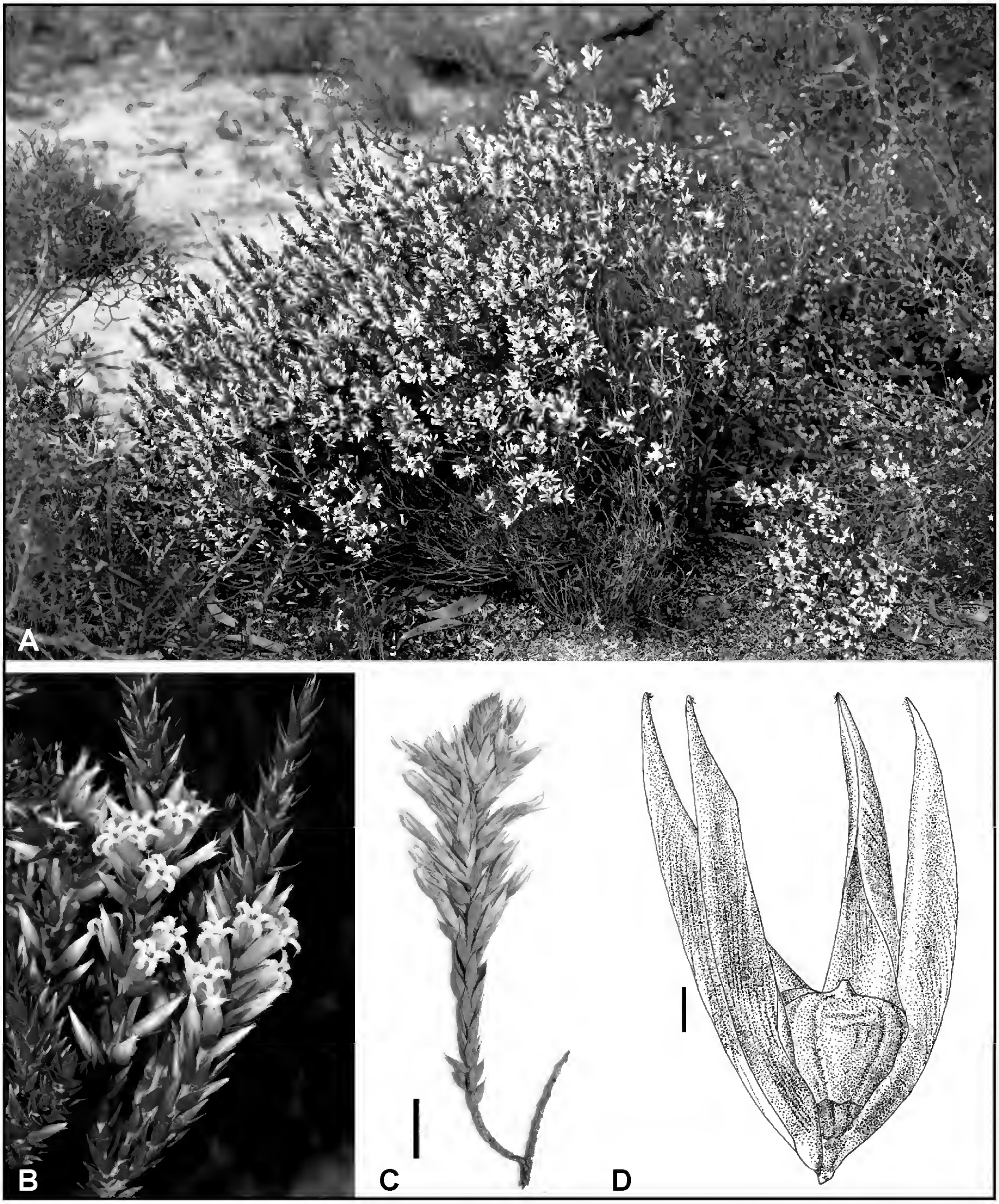

Figure 1. *Styphelia angustiflora*. A – habit; B – flowering branchlet *in situ*; C – scanned image of flowering branchlet; D – fruit. Scale bars = 1 cm (C), 1 mm (D). Vouchers *R. Davis* 4220 (C), *F. Hort* 862 (D). Photographs by Fred and Jean Hort (A, B). Drawing by Skye Coffey (D).

basis of current knowledge its geographic range is less than 12 km on a north-south axis and less than 5 km from east to west.

Affinities. The topology of Group IX obtained by Puente-Lelièvre *et al*. (2016) indicates that the closest relative of *S. angustiflora* is *S. disjuncta*. The two can be readily distinguished by the distinctly

larger leaves and floral parts of *S. angustiflora* (measurements for *S. disjuncta* given in parenthesis): leaves 5–12 mm long with a mucro 1–2 mm long (*cf.* 3.0–6.8 mm long with a mucro 0.4−1.0 mm long); sepals 6.5−9.2 mm long (*cf.* 4.2–5.3 mm); corolla tube 6.2–7.8 mm long (*cf.* 3.4–4.2 mm); style 6.5–9.7 mm long (*cf.* 3.9–5.2 mm).

The fruits of the two species are also quite dissimilar. Those of *S. angustiflora* are wider than long with a more or less flat apical surface, while in *S. disjuncta* the drupe is significantly longer than wide and the apical surface ascends markedly towards the style base.

Styphelia angustiflora also resembles *S. xerophylla*. Indeed when the first collection of the new species reached the Western Australian Herbarium in 1987, it was regarded as an outlier of that species. The most significant morphological difference between the two relates to the gynoecium. Whereas in *S. angustiflora* the style base is abruptly differentiated from the ovary apex, in *S. xerophylla* it is smoothly attenuated such that, in flowering specimens, it is not clear where ovary becomes style. The flowers of *S. angustiflora* are also noticeably narrower, with narrower sepals (1.8–2.5 mm wide, *cf.* 3.0–4.3 mm in *S. xerophylla*), corolla tubes (2.8–3.1 mm wide, *cf.* 3.7–5.3) and corolla lobes (1.4–1.7 mm at base *cf.* 2.0–2.5 mm).

Notes. The phrase name that had been in use for this species, *A.* sp. sessile leaf (J.L. Robson 657), was not an apt one. It was coined to highlight a perceived difference between the new species and *S. xerophylla*. Although the petioles of *S. angustiflora* are usually shorter and less conspicuous than those of *S. xerophylla*, the leaves are never truly sessile.

Styphelia cernua Hislop & Puente-Lel., *sp. nov.*

Typus: north-east of Port Gregory [precise locality withheld for conservation reasons], Western Australia, 7 July 2010, *C. Puente-Lelièvre, M. Hislop & E.A. Brown* CPL 63 (*holo*: PERTH 08281998; *iso*: CANB, K, MEL, NSW).

Astroloma sp. Kalbarri (D. & B. Bellairs 1368), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au [accessed 21 February 2019].

Erect *shrubs* to *c*. 1.7 m high and 1.5 m wide, from a fire-sensitive rootstock. Young *branchlets* with a sparse or moderately dense indumentum of ± patent hairs, to *c*. 0.05 mm long. *Leaves* antrorse, usually steeply so; apex long-mucronate, pungent, the mucro 0.8–1.5 mm long; base cuneate to attenuate; petiole well-defined, 1.0–1.7 mm long; lamina narrowly obovate to narrowly obovate-elliptic, 9.0–18.0 mm long, 2.0–3.2 mm wide, concave adaxially, longitudinal axis straight to gently incurved; surfaces distinctly discolorous; adaxial surface ± shiny, glabrous, except for a few hairs towards the base, venation not evident; abaxial surface paler, matt, grooved, with 7–9 raised, primary veins and narrow, prominent grooves between, shortly hairy in the grooves; margins narrowly hyaline, usually irregularly ciliate when young, the hairs soon abrading, leaving only the thickened bases, or occasionally the margins glabrous. *Inflorescence* axillary, widely spreading to more or less pendulous; axis 3.4–5.2 mm long, 1- or less often 2-flowered, ± terete in lower portion, flat and bract-like above the upper fertile node and terminating in a bud rudiment, with a moderately dense indumentum throughout; flowers sessile. *Fertile bracts* broadly elliptic, ± orbicular to transversely elliptic, 1.3–2.1 mm long, 1.5–2.0 mm wide, subtended by 4–5 smaller, sterile bracts. *Bracteoles* ovate, elliptic or ± orbicular, 2.6–3.5 mm long, 2.0–2.7 mm wide, obtuse to subacute, mucronate; abaxial surface striate, not keeled, shortly hairy, pale green in the basal half and straw-coloured above or straw-coloured throughout when dry; margins

ciliate. *Sepals* narrowly ovate, 5.6–6.5 mm long, 2.5–2.8 mm wide, acute, mucronate; abaxial surface striate, glabrous or hairy with a short antrorse indumentum, straw-coloured when dry, sometimes with pink tinges; adaxial surface glabrous except for a discrete patch of hairs close to the base; margins ciliate with hairs to 0.4 mm long. *Corolla tube* white, ellipsoid or obovoid, about equal to, or a little shorter than the sepals, 4.5–5.8 mm long, 3.4–3.8 mm wide, glabrous externally, internal surface with hairs extending into the top of the tube below the lobes. *Corolla lobes* white, shorter than the tube, 2.6–3.2 mm long, 1.6–2.0 mm wide at base, erect for *c.*1/4 of their length and then spreading and recurved; external surface mostly glabrous but becoming papillate towards the apex, internal surface with a dense indumentum of twisted, strongly ornamented hairs. *Filaments* terete, glabrous, 0.4–0.5 mm long, attached to anther 2/3–3/4 above the base, adnate to tube just below the sinuses. *Anthers* partially exserted from the tube (by 1/4–1/3 of their length), 3.0–3.8 mm long, apex distinctly emarginate to ± truncate. *Nectary* annular, 0.6–0.9 mm long, shallowly lobed, glabrous or minutely papillate. *Ovary* pale green, globose or ellipsoid, *c.* 1.0–1.5 mm long (but refer comment under notes below), 1.0–1.5 mm wide, glabrous, 5-locular, with indistinct longitudinal ribs. *Style* scabrous or very shortly hairy in the upper half, *c.* 4.0–5.0 mm long (but refer comment under notes below), tapering gradually from the ovary apex, slightly exserted from the tube with the stigma held at *c.* the level of the erect bases of the corolla lobes; stigma slightly expanded. *Fruit* ellipsoid, 6.2–7.0 mm long and 4.0–4.5 mm wide, slightly longer than calyx, the surface rugose with a markedly raised reticulum; gynophore absent. (Figure 2)

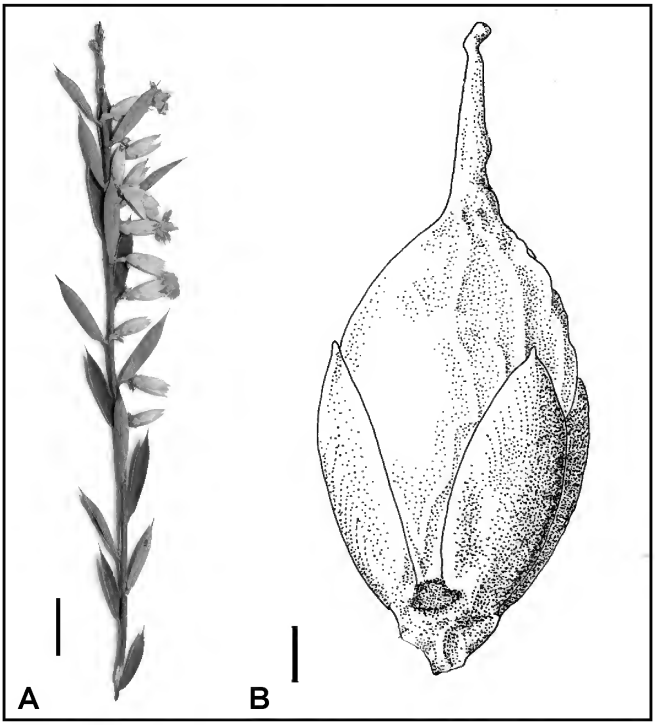

Figure 2. *Styphelia cernua*. A – scanned image of flowering branchlet; B – fruit. Scale bars = 1 cm (A), 1 mm (B). Vouchers *C. Puente-Lelièvre, M. Hislop & E.A. Brown* CPL 63 (A), *A. Franks, S. Branigan & B. Smith* BS 35 (B). Drawing by Skye Coffey (B).

Diagnostic characters. Within the *S. xerophylla* group, *S. cernua* is distinguished by the following character combination: leaf abaxial surface narrowly and prominently grooved with short hairs in the grooves; inflorescences widely spreading to ± pendulous; ovary glabrous, 5-locular; style tapering smoothly from ovary apex; fruit ellipsoid.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 July 1993, *D. & B. Bellairs* 1368 (PERTH); 17 May 1995, *D. & B. Bellairs* 1372 (PERTH); 9 July 1997, *R. Davis* 3669 (PERTH); 1 Nov. 2005, *A. Franks, S. Branigan & B. Smith* BS 35 (PERTH); 24 July 2008, *M. Hislop* 3779 (CANB, NSW, PERTH); 8 July 2010, *C. Puente-Lelièvre, M. Hislop & E.A. Brown* CPL 63A (NSW, PERTH); 30 Aug. 2006, *M. Weir* 100 (CANB, PERTH).

Distribution and habitat. *Styphelia cernua* has a restricted distribution in and around Kalbarri National Park in the northern part of the Geraldton Sandplain bioregion (Figure 3). In this area it occurs on white or yellow sandplain in low, open woodland or heath. Commonly associated species include *Banksia prionotes*, *Acacia scirpifolia*, *Daviesia divaricata*, *Jacksonia rigida* and *Scholtzia* spp.

Phenology. The main flowering period is between June and August. Although the only specimen with mature fruit was collected in early November, it could be expected that fruit would be present between September and November.

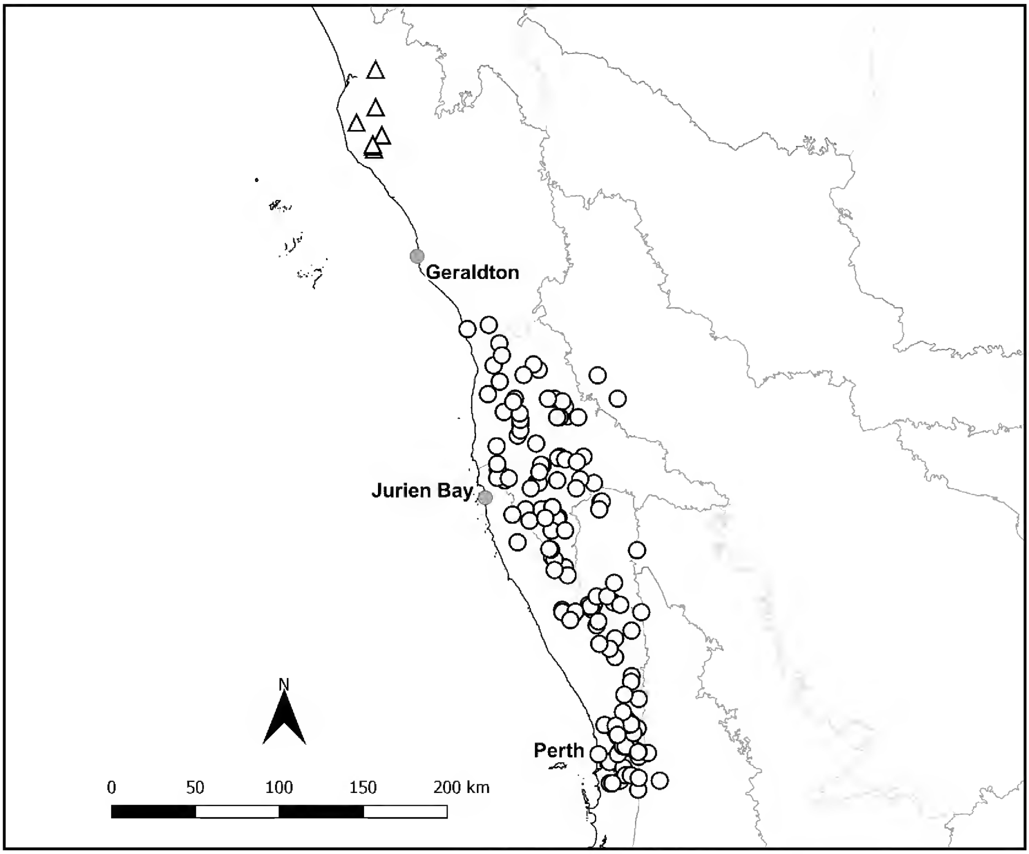

Figure 3. Distribution of *Styphelia cernua* (△) and *S. xerophylla* (○) in Western Australia.

Etymology. From the Latin *cernuus* (slightly drooping), a reference to the orientation of the flowers. This species being the only one in the group not to have an erect inflorescence.

Conservation status. Recently listed as Priority Two under Conservation Codes for Western Australian Flora under the name *Astroloma* sp. Kalbarri (D. & B. Bellairs 1368) (Western Australian Herbarium 1998–). *Styphelia cernua* is currently known from less than 10 collections. Most of these are from a relatively small area south of Kalbarri National Park, with only two having been made within the park boundaries. Its distribution and frequency inside the park needs to be investigated.

Affinities. This species is most similar to, and had previously been included in, *Styphelia xerophylla*. It differs from that species in its widely spreading to more or less pendulous inflorescences and smaller floral parts (measurements for *S. xerophylla* given in parenthesis): sepals 5.6–6.5 mm long (*cf.* 7.5–9.0 mm); corolla tube 4.5–5.8 mm long (*cf.* 6.0–8.2 mm); corolla lobes 2.6–3.2 mm long (*cf.* 4.0–5.2 mm). There is also a foliar difference with the abaxial leaf surfaces of *S. cernua* being deeply and narrowly grooved and shortly hairy within the grooves, whereas in *S. xerophylla* they are more shallowly grooved and either glabrous or with scattered hairs across the entire surface. The two species typically also have a different fruit shape: ellipsoid in *S. cernua* and usually ± globose in *S. xerophylla* (but refer to the notes heading under the latter for discussion of some variation that has been observed in regard to this character).

The two species are allopatric with the southernmost population of *S. cernua* about a 160 km to the north-east of the most northerly known population of *S. xerophylla*.

Notes. Because the style tapers so gradually from the ovary apex in this species the given measurements for the ovary and style lengths are necessarily imprecise.

Styphelia disjuncta Hislop & Puente-Lel., *sp. nov.*

Typus: west of Lake Grace [precise locality withheld for conservation reasons], Western Australia, 28 August 2001, *M. Hislop* 2272 (*holo*: PERTH 05826616; *iso*: CANB, MEL, NSW).

Leucopogon sp. Ongerup (A.S. George 16682), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au [accessed 21 February 2019].

Erect, compact shrubs to *c*. 60 cm high and 60 cm wide, branching from close to the base but with a fire-sensitive rootstock. Young *branchlets* with a dense indumentum of mostly retrorse hairs, 0.05–0.15 mm long. *Leaves* steeply antrorse to antrorse-appressed; apex long-mucronate, with a rather delicate, scarcely pungent mucro, 0.4–1.0 mm long; base obtuse to rounded; petiole well-defined, broad, 0.3–0.5 mm long; lamina ovate to narrowly ovate, 3.0–6.8 mm long, 1.2–2.4 mm wide, strongly concave adaxially, longitudinal axis gently incurved; surfaces slightly discolorous, shiny; adaxial surface glabrous, or with a few scattered hairs towards the base and apex, venation not evident; abaxial surface glabrous, paler, shallowly grooved, with 7–9 raised primary veins and broad, shallow grooves between; margins of most leaves conspicuously hyaline (only those produced towards the end of a growth flush without hyaline margins), variably ciliate to ± glabrous. *Inflorescence* axillary, erect; axis 1.9–2.6 mm long, 1-flowered, ± terete in lower portion, flat and bract-like above the fertile node and terminating in a bud rudiment, sparsely hairy on the terete portion with a moderately dense indumentum on all surfaces of the flat portion; flowers sessile. *Fertile bracts* ovate, 1.3–1.8 mm long, 1.0–1.3 mm wide, subtended by 4 or 5 smaller, sterile bracts. *Bracteoles* broadly ovate, ovate or elliptic,

2.0–2.6 mm long, 1.7–1.8 mm wide, obtuse, with a very short sub-terminal mucro; abaxial surface striate, not keeled, shortly hairy, straw-coloured when dry; margins ciliolate. *Sepals* narrowly ovate-elliptic, 4.2–5.3 mm long, 1.6–2.0 mm wide, obtuse to acute, indistinctly mucronate; abaxial surface striate, with a sparse to moderately dense indumentum of short, antrorse hairs, straw-coloured when dry; adaxial surface with a well-defined patch of hairs towards the base and scattered hairs in the upper half; margins ciliate with hair to 0.2 mm long. *Corolla tube* white, narrowly obovoid or narrowly ellipsoid, shorter than the sepals, 3.3–4.2 mm long, 1.8–2.0 mm wide, glabrous externally, internal surface with hairs extending below the lobes. *Corolla lobes* white, from shorter than to occasionally equal to the tube, 3.2–4.0 mm long, 1.0–1.2 mm wide at base, erect for 1/3–1/2 of their length and then spreading and recurved; glabrous externally, internal surface with a dense indumentum of twisted, ornamented hairs. *Filaments* terete, glabrous, 0.4–0.5 mm long, attached to anther 1/2–2/3 above the base, adnate to tube just below the sinuses. *Anthers* partially exserted from the tube (by 1/2–2/3 of their length), 1.7–2.2 mm long, apex emarginate. *Nectary* annular, 0.4–0.5 mm long, shallowly lobed, glabrous. *Ovary* pale green, globose, 0.9–1.2 mm long, 0.9–1.1 mm wide, glabrous, deeply rugose, 3-locular. *Style* scabrous in the upper half, 3.9–5.2 mm long, well-differentiated from the ovary apex, exserted from the corolla tube with the stigma held at *c.* the level of the erect bases of the corolla lobes; stigma distinctly expanded. *Fruit* obovoid, 3.0–3.5 mm long, 1.8–2.2 mm wide, much shorter than the calyx, shallowly rugose with indistinct longitudinal grooves also evident; the apical surface distinctly raised towards the style base; gynophore absent. (Figure 4)

Diagnostic characters. Within the *S. xerophylla* group, *S. disjuncta* is distinguished by the following character combination: short leaves (the longest < 7 mm long); leaf abaxial surfaces shallowly and broadly grooved; ovary glabrous, 3-locular; style abruptly differentiated from the ovary apex; fruit obovoid.

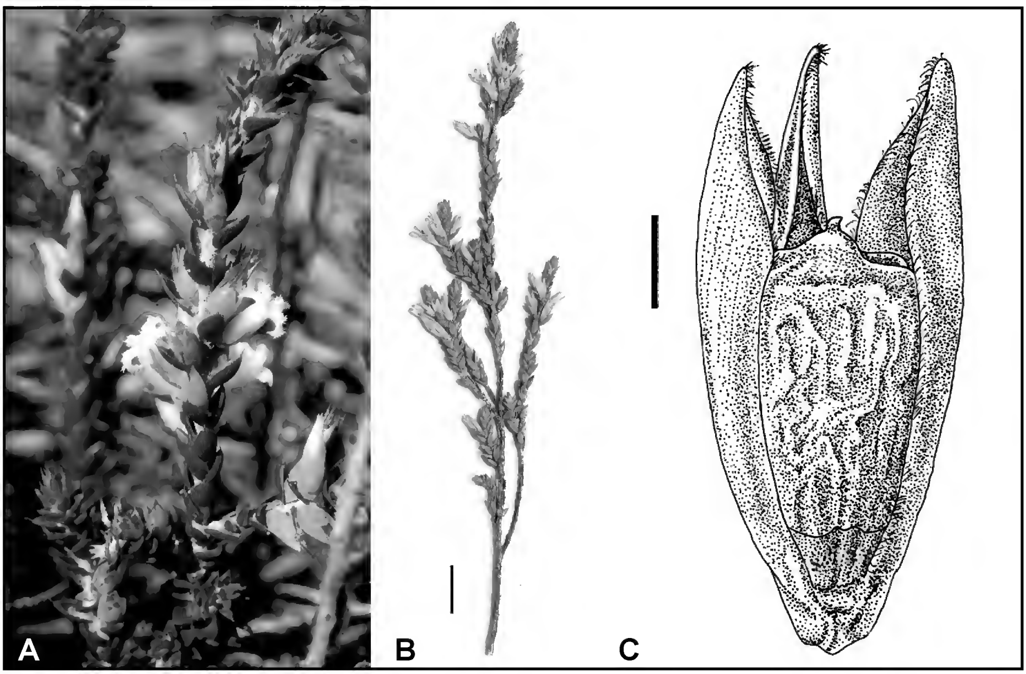

Figure 4. *Styphelia disjuncta*. A – flowering branchlet *in situ*; B – scanned image of flowering branchlet; C – fruit. Scale bars = 1 mm (C), 1 cm (B). Vouchers *M. Hislop* 2272 (B), *M. Hislop* 3063 (C). Photograph by Jolanda Keeble (A). Drawing by Skye Coffey (C).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 27 June 2003, *S. Barrett* 1109 (PERTH); 1 Sep. 2005, *J.A. Cochrane & S. Barrett* JAC 5386 (K, PERTH); 16 Oct. 2007, *J.A. Cochrane* JAC 6871 (PERTH); 29 July 1986, *A.S. George* 16682 (CANB, PERTH); 12 Oct. 2003, *M. Hislop* 3063 (PERTH); 19 July 2016, *M. Hislop* 4610 (PERTH); *17* July 1965, *K. Newbey* 1808 (PERTH); 4 Aug. 1969, *K. Newbey* 2833 (PERTH); 31 May 1970, *K. Newbey* 3184 (PERTH); 26 July 2002, *L. Polomka & S. Patrick* SP 4208 (PERTH).

Distribution and habitat. *Styphelia disjuncta* has a restricted, disjunct distribution in the Dumbleyung and Ongerup areas at the western end of the Mallee bioregion. Grows in sand or sandy loam soils over laterite, and in association with species-rich heath or open mallee woodland.

Phenology. The main flowering period appears to be between June and early September. Collections with mature fruit present have been made in September and October.

Etymology. The epithet is derived from the Latin *disjunctus* (separate, distinct), a reference to the significant geographic disjunction between the northern and southern populations.

Conservation status. Listed as Threatened Flora in Western Australia with a ranking of Vulnerable (Smith & Jones 2018) under the name *L.* sp. Ongerup (A.S. George 16682). Currently known only from three small populations, the two northern ones being around 100 kilometres distant from the southern population.

Affinities. *Styphelia disjuncta* is morphologically most similar to, and only likely to be confused with, *S. angustiflora*. The differences between the two are given under *S. angustiflora*.

Notes. Despite the significantly disjunct distribution, there is little morphological difference between the populations. Relative to those from the northern populations there is a tendency for plants from the southern population to have somewhat longer inflorescence axes and very slightly larger floral parts.

Styphelia stomarrhena (Sond.) Sleumer, *Blumea* 12: 154 (1964); *Astroloma stomarrhena* Sond. in Lehm., *Pl. Preiss.* 1(2): 301 (1845). *Type*: In regionibus interioribus Australasiae occidentalis [Western Australia], *s. dat.*, *L. Preiss* 410 (*syn*: LD 1075918, MEL 1549325); In Australia occidentali [Western Australia], 1843, *J. Drummond* 467 (*n.v.*).

Styphelia lasionema F.Muell., *Fragm.* 6: 40 (1867). *Type*: Swan River [Western Australia], *s. dat.*, *J. Drummond* 475 (*syn*: K 000277501, MEL 1549327); Ibidem ad oppidulum Hamdeni [Western Australia], *s. dat.*, *W. Clarke s.n.* (*syn*: MEL 1549326).

Low, spreading, compact *shrubs* to *c.* 30 cm high and 40 cm wide, multi-stemmed from a fire-tolerant rootstock. Young *branchlets* with a moderately dense to dense indumentum of ± patent hairs, < 0.05–1.50 mm long. *Leaves* mostly steeply antrorse; apex long-mucronate, pungent, the mucro 1.3–2.0 mm long; base attenuate to cuneate; petiole well-defined, 0.7–2.0 mm long; lamina narrowly elliptic to narrowly obovate-elliptic, 10–23 mm long, 2.7–4.5 mm wide, strongly concave adaxially, longitudinal axis gently incurved; surfaces discolorous; adaxial surface shiny, with a sparse or moderately dense indumentum, or occasionally glabrous, venation not or barely evident; abaxial surface paler, usually with a dimorphic indumentum consisting of a layer of sparse or moderately dense short hairs overtopped by a sparse layer of much longer, coarse hairs, occasionally one or both (i.e. surface glabrous) of the layers absent, openly grooved between 7–9 raised primary veins;

margins usually variably ciliate, sometimes ± glabrous. *Inflorescence* axillary, erect, 3.4–5.0 mm long, 1(2)-flowered, ± terete and obscured by bracts in the lower portion, flat and bract-like above the fertile node and terminating in a bud-rudiment, flat portion hairy on all surfaces; flowers sessile. *Fertile bracts* elliptic, 2.8–3.8 mm long, 2.0–2.8 mm wide, subtended by 4 smaller sterile bracts. *Bracteoles* elliptic, 3.7–5.0 mm long, 2.4–3.3 mm wide, acute, mucronate; abaxial surface striate, not keeled, hairy with longer spreading hairs in the upper half, straw-coloured when dry; margins ciliate. *Sepals* narrowly elliptic or narrowly obovate-elliptic, 7.0–8.5 mm long, 2.6–3.8 mm wide, acute and mucronate; abaxial surface striate, with a moderately dense to dense indumentum of shallowly antrorse hairs, mostly in the upper half, straw-coloured when dry; adaxial surface glabrous throughout; margins ciliate at least in the upper half, with hairs 0.1–0.5 mm long. *Corolla tube* red, narrowly obovoid, much longer than the sepals, 10.2–16.5 mm long, 4.0–5.2 mm wide, glabrous externally, internal surface with 5 ± well-defined hair tufts close to the base and scattered hairs between the tufts and tube apex. *Corolla lobes* red, much shorter than the tube, 6.0–7.4 mm long, 2.2–3.0 mm wide at base, erect for up to *c.* 1/4 of their length and then spreading and recurved to revolute; external surface hairy in the upper half (the hairs with smooth surfaces); internal surface with a sparse indumentum of twisted and ornamented hairs, becoming denser towards the base and apex. *Filaments* plano-convex, stout, densely hairy with twisted, ornamented hairs, 4.4–5.5 mm long, adnate to the tube just below the sinuses, attached just below anther apex. *Anthers* well exserted from the tube, 2.0–2.8 mm long, cohering for much of their length, apex entire. *Nectary* annular, 0.6–1.0 mm long, shallowly lobed, glabrous. *Ovary* mid-green, globose to ovoid, 1.1–1.5 mm long, 1.1–1.3 mm wide, glabrous, 4- or 5-locular. *Style* glabrous or minutely scabrous immediately below the stigma, 14–24 mm long, well-differentiated from ovary apex, well-exserted from corolla tube; stigma lobed, much expanded. *Fruit* depressed-obovoid, with the upper surface ± flat except for a small raised area at the style base, 3.5–3.8 mm long, 4.2–4.8 mm wide, much shorter than the calyx, the surface rugose; gynophore absent. (Figure 5)

Selected specimens examined. WESTERN AUSTRALIA: Ellis Brook Valley Reserve [Orange Grove], 19 May 1999, *H. Bowler* 560 (PERTH); Brand Hwy, 6.9 km N of Greenhead Rd, 27 May 1997, *R. Davis* 3232 (PERTH); Cadda Rd, *c.* 11.5 km WSW of Badgingarra, 29 July 2012, *R. Davis* 12101 (PERTH); Lesueur National Park, S break of buffer to Mt Peron, 200 m E of Cockleshell Gully Rd, 20 June 1993, *B. Evans* WE 627 (PERTH); depressions near Cannington, June 1935, *C.A. Gardner s.n.* (PERTH); 8 km SW of Eneabba, 9 July 1977, *E.A. Griffin* 912 (PERTH); Irwin, 9 July 1986, *R. Gueho* 6 (PERTH); remnant bushland, adjacent ACTIV Industries, High Wycombe, 6 June 1998, *M. Hislop* 1060 (PERTH); Hi Vallee property (D. & J. Williams) Warradarge, above NW head of main valley, 15 July 2001, *M. Hislop, F. & J. Hort* MH 2256 (PERTH); Reserve No. 29801 E of Warradarge, along S internal firebreak adjacent to Greenhead–Coorow Rd, 18 July 2004, *M. Hislop* 3281 (PERTH); Boonanarring Brook, 25 km NNE of Gingin, 25 May 1988, *G.J. Keighery* 10050 (PERTH); 24.7 km E of Jurien Bay on road to Brand Hwy, 15 Aug. 1986, *J.M. Powell* 2522 (NSW, PERTH); White Rd Plot 1, *c.* 120 m from Kelvin Rd, and 80 m from White Rd, Orange Grove, 19 July 2006, *J. Pryde & M. Hoskins* MM 2 (PERTH); walking track of Badgingarra National Park on Brand Hwy, front of roadhouse petrol station, 6 July 2010, *C. Puente-Lelièvre & E.A. Brown* CPL 50 (NSW, PERTH); Forrestfield–Welshpool Rd, 0.5 km from Lewis Rd, in bushland patch N of road, 13 Aug. 2009, *K.R. Thiele* 3761 (PERTH); *c.* 13 km N of Jurien Rd junction on Cockleshell Gully Rd, 10 Aug. 1988, *A.J.G. Wilson* 128 (CBG, PERTH).

Distribution and habitat. *Styphelia stomarrhena* has a scattered distribution in the southern Geraldton Sandplains and northern Swan Coastal Plain bioregions, with limited occurrence in the adjacent parts of the Avon Wheatbelt and Jarrah Forest bioregions; from a little south of Eneabba to the eastern suburbs of of Perth and east as far as the Chittering area (Figure 6). Grows in deep sandy soils or sand over laterite, mostly in *Banksia* woodland or various heathland communities.

Figure 5. *Styphelia stomarrhena* flowering branchlet. Voucher *K. Thiele* 3761. Photograph by Kevin Thiele.

An old, undated specimen (*J.J. Havel s.n.*) with no information other than the collection locality, 'Coolup–Dwellingup Rd', ostensibly represents a disjunct southerly occurrence for the species. However with such scant collecting information and no other collections of the species having been made south of Perth there would seem to be the possibility that this is a locality-error.

Phenology. The main flowering period is between May and July. The only fruiting collections of the species were made in August, but presumably fruit is likely to be present at least until October.

Conservation status. Although quite widespread the species is rarely common locally; its occurrence at any locality is mostly described as occasional. It is however well represented on the conservation estate and no conservation coding is recommended here.

Notes. In the context of the morphology of Group IX as a whole *S. stomarrhena* is clearly anomalous in regard to a number of characters. Within the group it is the only species to have the following features (the usual character states given in parenthesis): red flowers (white); hair tufts present near the base of the internal corolla tube (hair tufts absent); anthers cohering, long-exserted from the corolla tube on hairy, stout, plano-convex filaments (anthers free, partially included within the tube on glabrous, slender, terete filaments); corolla lobes recurved to frequently revolute, hairs on internal surfaces unevenly distributed, mostly sparse but becoming denser towards the base and apex (corolla lobes recurved, never revolute, hairs on internal surfaces evenly distributed, dense); style much longer than the tube with the stigma ultimately presented well beyond the corolla lobes (style a little longer than

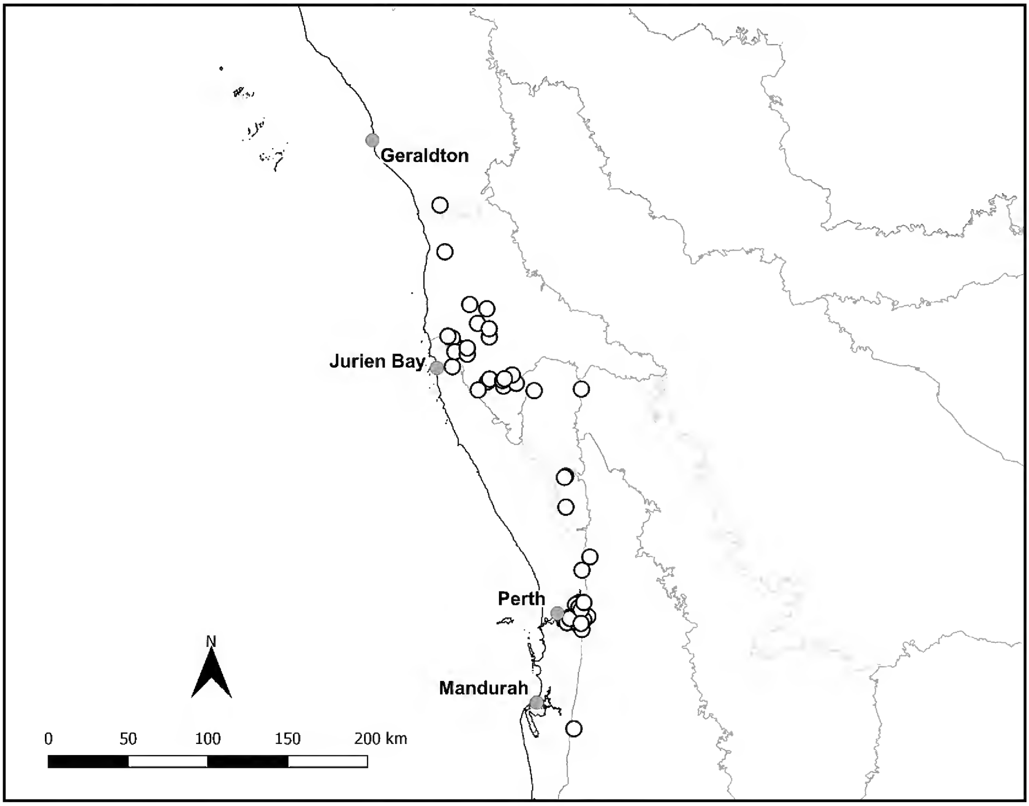

Figure 6. Distribution of *Styphelia stomarrhena* in Western Australia.

the tube with the stigma held at about the same level as the erect bases of the corolla lobes); rootstock fire-tolerant (fire-sensitive).

The red flower colour, long corollas (effectively made longer by the robust, densely hairy, exserted filaments), as well as differences in floral hair distribution, anther and stigma presentation strongly suggests that a particular pollination strategy is at work and has led to the morphological divergence exhibited by this species. Johnson (2013) has suggested that birds play a significant role in the pollination of epacrids with these features. This has been corroborated by field observations recorded by Michael Whitehead (pers. comm.) of the University of Melbourne during the course of recent research into the pollination systems of certain *Styphelia* species.

During flowering the stigma is held in two different positions. When the flowers first open it is presented at the top of the cohering anthers, which dehisce introrsely against the upper style. At this stage the style is bent into angles within the corolla tube. Later, the style straightens so as to be finally well-exserted beyond the anthers. It seems likely that this sequence is protandrous in effect.

There is an interesting difference in the shape of the ovary apex within the Western Australian Herbarium's holding of this species. Some specimens have the ovary tapering quite smoothly to the style base, while in others the style arises from a well-defined flat surface at the ovary apex, so that the style base is conspicuously narrower than the ovary apex. There is no obvious geographical pattern to this variation, neither does it appear to correlate with any other potentially significant taxonomic

difference. In order to evaluate whether this variation in ovary shape translates to a consistent difference in fruit shape it would be necessary to compare mature fruit of the two morphotypes. Currently there are only two fruiting collections of the species at the Western Australian Herbarium and they have very similar fruit, as given in the description above.

Styphelia sulcata Hislop & Puente-Lel., *sp. nov.*

Typus: north of Cascade [precise locality withheld for conservation reasons], Western Australia, 16 May 2002, *M. Hislop & F. Hort* 2598 (*holo*: PERTH 06132804; *iso*: CANB, NSW).

Leucopogon sp. Bonnie Hill (K.R. Newbey 9831), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au [accessed 21 February 2019].

Low, compact *shrubs* to *c.* 40 cm high and 40 cm wide, from a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of patent to shallowly antrorse hairs, 0.05–0.5 mm long. *Leaves* steeply antrorse; apex long-mucronate, the mucro very fine and brittle, scarcely pungent, 1.0–2.4 mm long; base attenuate to ± cuneate; petiole well-defined, 0.3–0.6 mm long; lamina narrowly ovate, 4.0–8.2 mm long, 0.8–1.6 mm long, adaxially concave, longitudinal axis incurved; surfaces slightly discolorous, shiny; adaxial suface glabrous, the venation not evident; abaxial surface slightly paler, strongly grooved, with 5–7 raised primary veins and deep, narrow grooves between, shortly and densely hairy in the grooves, the raised veins glabrous; margins usually coarsely ciliolate with very short, antrorse hairs, occasionally ± glabrous. *Inflorescence* axillary, erect; axis 1.5–2.7 mm long, 1-flowered, ± terete in lower portion, distinctly flattened above the fertile node and terminating in a bud rudiment, with a moderately dense indumentum throughout; flowers sessile. *Fertile bracts* narrowly ovate, 2.0–2.5 mm long, 0.9–1.3 mm wide, subtended by 4 smaller, sterile bracts. *Bracteoles* ovate, 2.8–3.5 mm long, 1.3–1.5 mm wide, acuminate, long-mucronate; abaxial surface striate, not keeled, shortly hairy, straw-coloured when dry, sometimes with pink tinges; margins ciliate. *Sepals* narrowly ovate, 4.8–5.5 mm long, 1.2–1.4 mm wide, acute and long-mucronate; abaxial surface striate, variably antrorse-hairy, at least in the upper half, straw-coloured, sometimes with pink tinges; adaxial surface hairy towards the apex and with a well-defined patch of hairs towards the base; margins ciliate with hairs to 0.3 mm long. *Corolla tube* white, narrowly obovoid to ± cylindrical, shorter than the sepals, 3.2–4.2 mm long, 1.6–2.1 mm wide, external surface with a sparse to moderately dense indumentum in the upper half, glabrous below, internal surface with hairs extending to a point below the anther bases. *Corolla lobes* white, shorter than, to longer than, the tube, 3.2–4.5 mm long, 0.9–1.1 mm wide at the base, erect for 1/4–1/3 of their length and then spreading and recurved; external surface with a sparse to moderately dense indumentum of antrorse hairs, internal surface with a dense indumentum of twisted and ornamented hairs. *Filaments* terete, glabrous, 0.2–0.3 mm long, attached to anther 1/2–2/3 above the base, adnate to tube just below sinuses. *Anthers* partially exserted from the tube (by 1/2–2/3 of their length), 1.7–2.3 mm long, apex emarginate. *Nectary* annular, 0.4–0.6 mm long, glabrous. *Ovary* pale to mid green, ellipsoid to obovoid, 0.8–1.0 mm long, 0.5–0.7 mm wide, glabrous, rugose, 2-locular. *Style* minutely scabrous throughout or at least in upper half, 3.2–4.2 mm long, well-differentiated from ovary apex, slightly exserted from corolla tube, with the stigma held at a point *c.* level with the recurved bases of the corolla lobes; stigma slightly expanded. *Fruit* ± cylindrical, 3.2–4.0 mm long, 1.2–1.6 mm wide, much shorter than the calyx, not rugose, with faint longitudinal striations; the apical surface ascending to the style base; a well-defined gynophore present. (Figure 7)

Diagnostic characters. Within the *S. xerophylla* group, *S. sulcata* is easily distinguished by the deep, narrow grooves on the abaxial leaf surfaces, the hairy external surfaces of the corolla tube and lobes and a 2-locular ovary.

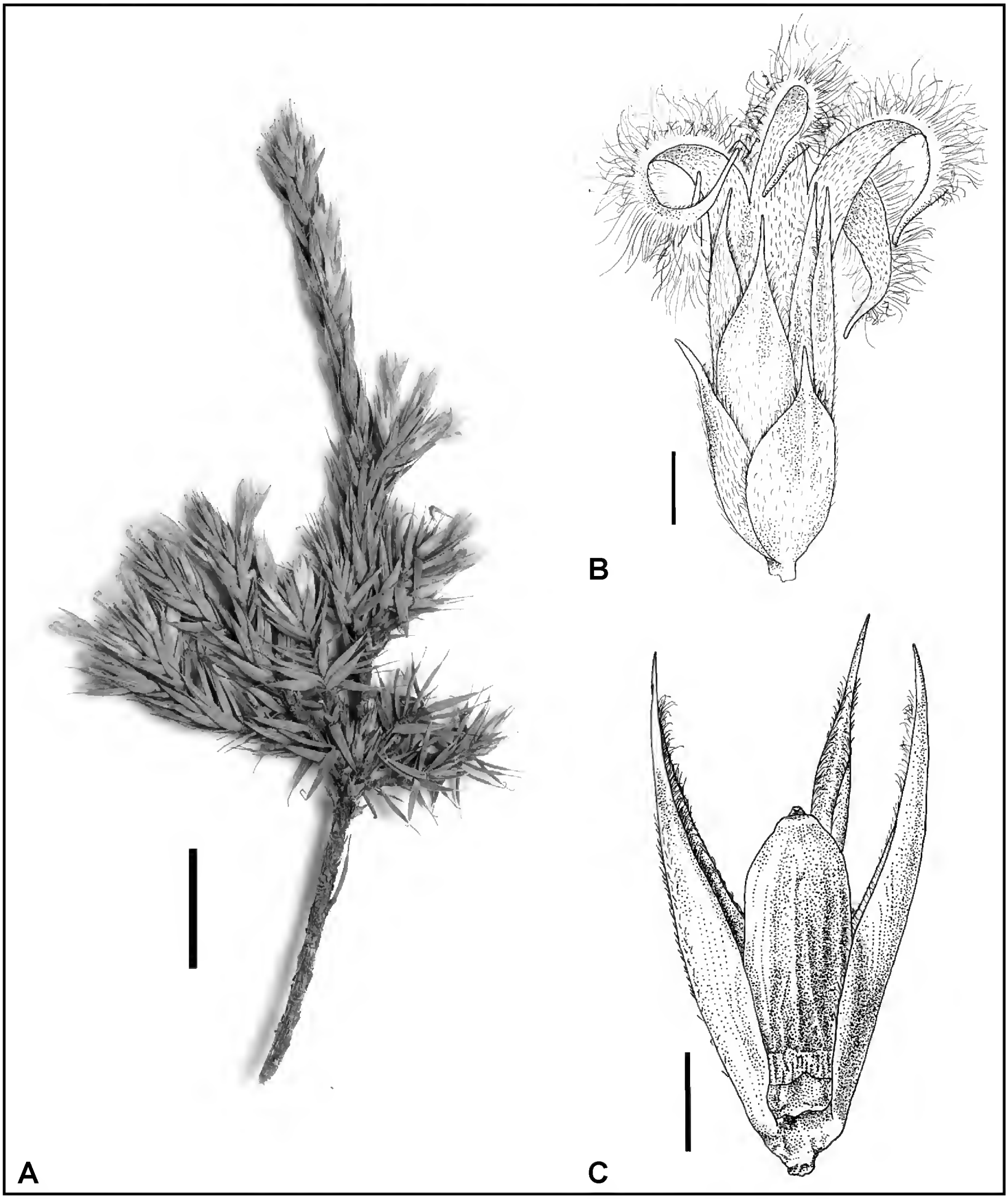

Figure 7. *Styphelia sulcata*. A – scanned image of flowering branchlet; B – flower, external view; C – fruit. Scale bars = 1 cm (A), 1 mm (C). Vouchers *M. Hislop & F. Hort* 2598 (A), *M. Hislop & F. Hort* 2598 (B), *M. Hislop* 4231 (C). Drawings by Skye Coffey (B, C).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 27 Sep. 1984, *M.A. Burgman* 3708 (PERTH); 24 May 1983, *M.A. Burgman & S. McNee* 1476 (PERTH); 13 Sep. 1992, *G.F. Craig* 2112 (PERTH); 19 Sep. 1993, *C.F. Craig* 2972 (PERTH); 21 Aug. 2012, *M. Hislop* 4231 (PERTH); 16 May 2002, *M. Hislop & F. Hort* MH 2600 (MEL, PERTH); 13 Oct. 2000, *G.J. Keighery & N. Gibson* 5597 (PERTH); 15 Nov. 1980, *K. Newbey* 8148 (PERTH); 10 May 1982, *K.R. Newbey* 9831 (PERTH).

Distribution and habitat. Has a disjunct distribution, north of Cascades and north-east of Condingup, in the Mallee bioregion. Grows in sandy soils in open mallee woodland. Associated species include *Eucalyptus leptocalyx*, *E. pleurocarpa*, *Calothamnus gracilis*, *Banksia media* and *Grevillea aneura*.

Phenology. Peak flowering is likely to be in May and June. Mature fruit is present on specimens collected in August and September.

Etymology. The epithet is derived from the Latin *sulcatus* (furrowed), a reference to the narrowly and deeply grooved abaxial leaf surfaces.

Conservation status. Priority One (Smith & Jones 2018) under Conservation Codes for Western Australian Flora under the name *Leucopogon* sp. Bonnie Hill (K.R. Newbey 9831).

Styphelia sulcata is very poorly known and needs to be surveyed as a matter of priority. Because of imprecise label details it is not clear whether the collections from the western distribution node are from one or more populations. When the type collection was made in 2002 the species was very common locally, with at least many hundreds, and probably several thousand plants. However in 2012 when the first author revisited the site, there had been a wildfire in the intervening years and only occasional plants were seen. The eastern distribution node is currently represented by a single collection made in 1982; its precise locality is unknown.

Although on the strength of our current knowledge there is cause for concern that this is a rare plant, it must also be acknowledged that both population nodes occur in remote areas of Western Australia containing large tracts of natural vegetation. There must therefore still be a good chance that future survey will bring to light new populations.

Affinities. This species was not included in the molecular phylogenetic analysis of Puente-Lelièvre *et al.* (2016), and its position as the seventh member of Group IX is based on morphology alone. Although possessing the core morphological attributes of the group, as described above, there is a significant difference in its fruiting character. Rather than having the usual fleshy drupe this species has a very-reduced mesocarp (more or less dry) and with a well-defined gynophore. None of the other species in the group has a fruiting gynophore although a very-reduced mesocarp is the norm in Group VIII, the sister group to Group IX. It is worth noting in this regard that *Styphelia erubescens* F.Muell. (until recently treated as *Leucopogon oxycedrus* Sond.) of Group V is a confirmed example of another species with a ± dry drupe and a fruiting gynophore that is nested within a group in which all of its closest relatives have a fleshy mesocarp and no gynophore. *Styphelia sulcata* is also the only species in the group in which the external surface of the corolla tube is hairy.

Styphelia xerophylla (DC.) F.Muell., *Fragm.* 6: 38 (1867); *Stomarrhena xerophylla* DC., *Prodr.* 7(2): 738 (1839); *Astroloma xerophyllum* (DC.) Sond. in Lehm., *Pl. Preiss.* 1(2): 301 (1845). *Type*: In Novâ Hollandiâ ad Swan River [Western Australia], 1835–1838, *J. Drummond s.n.* (*holo*: GDC G00464096).

Erect, compact shrubs, to *c.* 60 cm high and 60 cm wide, branching from close to base but with a fire-sensitive rootstock. Young *branchlets* with a moderately dense to dense indumentum of patent to shallowly antrorse hairs, 0.05–0.60 mm long. *Leaves* variably antrorse or occasionally some leaves patent to shallowly retrorse; apex long-mucronate, pungent, the mucro 0.6–1.2 long; base attenuate, cuneate or sometimes rounded; petiole well-defined, 1.0–1.8 mm long; lamina narrowly ovate to ovate, narrowly elliptic to elliptic, or sometimes obovate, 5–20 mm long, 1.6–3.8 mm wide, strongly concave

adaxially, sometimes ± stem-clasping, longitudinal axis gently incurved, ± straight or occasionally gently recurved; surfaces discolorous shiny; adaxial surface glabrous or sparsely hairy, venation not evident; abaxial surface paler, glabrous or sparsely hairy with 5–9 raised primary veins, broadly grooved, or sometimes ± flat between the veins; margins glabrous or irregularly ciliate. *Inflorescence* axillary, erect; axis 2.5–3.6 mm long, 1-flowered, ± terete in lower portion, flat and bract-like above the fertile node and terminating in a bud rudiment, sparsely hairy on the terete portion, with a moderately dense indumentum on the flat portion; flowers sessile. *Fertile bracts* orbicular, depressed-ovate or broadly ovate, 1.8–2.8 mm long, 2.1–3.0 mm wide, subtended by 4–5 smaller, sterile bracts. *Bracteoles* broadly ovate to broadly elliptic to ± orbicular, 3.0–4.2 mm long, 2.4–3.6 mm wide, obtuse with a very short, sub-terminal mucro; abaxial surface striate, not keeled, glabrous or with spreading hairs, straw-coloured when dry, sometimes with a pinkish tinge; margins ciliolate. *Sepals* narrowly elliptic or narrowly ovate-elliptic, 7.5–9.0 mm long, 3.0–4.3 mm wide, obtuse to subacute, shortly mucronate; abaxial surface finely striate, glabrous or sparsely hairy, straw-coloured when dry, sometimes with a pinkish tinge; adaxial surface with a well-defined patch of hairs towards the base; margins ciliate with hairs <0.05–0.20 mm long. *Corolla tube* white, obloid or narrowly obovoid, usually shorter than, but sometimes longer than, the sepals, 6.0–8.2 mm long, 3.7–5.3 mm wide, glabrous externally, internal surface with hairs extending to a point well below the anther bases. *Corolla lobes* white, shorter than the tube, 4.0–5.2 mm long, 2.0–2.5 mm wide at base; erect for basal 1/3–1/2 of their length and then spreading and recurved; external surface glabrous, internal surface with a dense indumentum of twisted, ornamented hairs. *Filaments* terete, glabrous, 0.6–1.0 mm long, attached to anther 2/3–3/4 above the base, adnate to tube just below the sinuses. *Anthers* partially exserted from the tube (by 1/3–2/3 of their length), 2.2–3.6 mm long, apex emarginate and often slightly recurved. *Nectary* annular, 0.4–0.8 mm long, truncate or lobed, glabrous or minutely papillate, longitudinally grooved below the sinuses. *Ovary* pale green, globose, *c.* 1.2–1.5 mm long (but refer comment under notes below), 1.2–1.4 mm wide, glabrous, strongly rugose, 5-locular. *Style* scabrous in the upper half, *c.* 6.2–8.0 mm long (but refer comments under notes below), tapering gradually from the ovary apex, slightly exserted from the corolla tube with the stigma held at *c.* the level of the erect bases of the corolla lobes; stigma slightly expanded. *Fruit* ± globose (but refer exception under notes below), 3.7–4.2 mm long and 3.8–4.2 mm wide, much shorter than the calyx, the surface rugose, at least in the upper half; gynophore absent. (Figure 8)

Selected specimens examined. WESTERN AUSTRALIA: Gillingarra West Rd [NW of Mogumber], 4 Oct. 2006, *C. Danese & D. Rayner* B 1006-43 (PERTH); Brand Hwy (truck stop), 32 km N of Eneabba turnoff, 19 June 1997, *R. Davis* 3392 (PERTH); AMG 50JLL811721, W of S end of Moochamulla Rd, N of Moore River, 12 Aug. 1988, *E.A. Griffin* 4929 (MEL, PERTH); Alexander Morrison National Park, S side of Green Head−Coorow Rd, 18.3 km E of Brand Hwy, 13 Nov. 2004, *M. Hislop* 3349 (CANB, NSW, PERTH); High Hill corner of Badgingarra National Park, on internal firebreak *c.* 150 m W of corner, 26 July 2008, *M. Hislop* 3788 (NSW, PERTH); Boothendarra Nature Reserve, off Boothendarra Rd 5.2 km E of Dewar Rd, NE of Badgingarra, 16 Aug. 2008, *M. Hislop* 3801 (CANB, NSW, PERTH); intersection of Mt Adams Rd and the gas pipe line [SE of Dongara], 3 Aug. 1994, *E.D. Kabay* 297 (PERTH); Chandala Nature Reserve, Ioppolo Rd, S of Gingin, 27 July 2005, *G.J. Keighery* 16680 (PERTH); site 23, 2.25 km E along Wongonderrah Rd from the turn off to Nambung Homestead, then due S along track for 2 km, 29 Oct. 1999, *C. MacPherson s.n.* (PERTH); Gnangara−Moore River State Forest, Melaleuca block, 50 m N of a point 1360 m W along Quicke Rd from intersection of Quicke Rd and St Patrick Rd, Bullsbrook, 12.8 km ENE of Wanneroo, 25 Sep. 2008, *D.A. Mickle & M.L. Swinburn* 567 (PERTH); Reserve 28685 at Junction of Sundalara and Tomkins Rd, W of Arrino, 10 July 1991, *S. Patrick* 618 (PERTH); Cooljarloo, S end of gravel reserve in Conservation Park C41986, 8 Oct. 1991, *S. Patrick* 878 (PERTH); Jandakot area, 25 Aug. 1979, *J.M. Powell* 1320 (AD, CANB, CHR, NSW, NY, PERTH); Watheroo Rd, 28.7 km E of Brand Hwy,

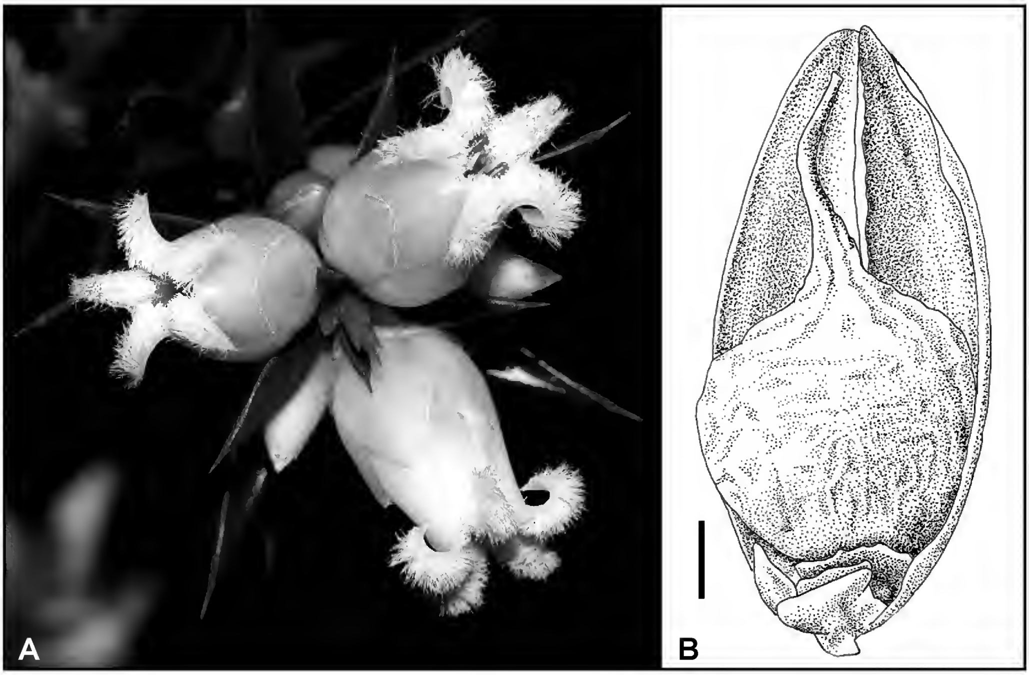

Figure 8. *Styphelia xerophylla*. A – flowering branchlet. B – fruit. Scale bar = 1 mm (B). Voucher *M.E. Trudgen* 20474 (B). Photograph by Rob Davis (A). Drawing by Skye Coffey (B).

14 Aug. 1986, *J.M. Powell* 2497 (HO, K, NSW, PERTH); Hi Vallee property along E track in the main valley, locality of Warradarge, 7 July 2010, *C. Puente-Lelièvre, M. Hislop & E.A. Brown* CPL 57 (NSW, PERTH); 300 m into bush on E side, 1.1 km S on Amherst Rd from Warton Rd, Gosnells, 17 Aug. 1996, *L. Sage* 694 (PERTH); N of Gnangara Rd, towards SE part of Lot 47 Lexia Ave., locality of Ellenbrook, 30 July 1999, *M. Trudgen & M. Trudgen* MET 20006 (K, MEL, PERTH).

Distribution and habitat. Widespread in the southern Geraldton Sandplains and northern Swan Coastal Plain bioregions, with limited occurrence in the adjacent parts of the Avon Wheatbelt and Jarrah Forest bioregions; from the Mount Adams area south to the southern suburbs of Perth and east as far as the Arrino area and Wannamal (Figure 3). *Styphelia xerophylla* grows in deep sandy soils or sand over laterite, mostly in *Banksia* woodland or various heathland communities.

Phenology. The main flowering period is between June and September. Mature fruit is present on specimens collected between September and November.

Conservation status. A common species, well represented on the conservation estate.

Notes. On the uplands of the Dandaragan Plateau in the north-east of the species' range there occurs a variant (e.g. *M. Hislop* 3001 & 3801) that differs from the typical form in having relatively shorter and broader leaves. The flower size of this variant is also consistently at the upper end of the range seen in the species as a whole, but no other qualitative floral or fruiting differences were identified during this study.

Styphelia xerophylla is a well-collected species with more than 160 specimens currently housed at the Western Australian Herbarium. These provide ample evidence that a globose fruit shape is the norm for the species across most of its range. However there are a few specimens that are aberrant in having ovoid drupes, distinctly longer than wide. One of these (*J. D'alonzo* 15) is from Karragullen in the Darling Range close to Perth. This collection is also noteworthy because it is the only one from laterite on the Darling Range, all other collections from the Perth region being from the deep sands of the coastal plain.

Two other collections with ovoid fruit (*E.A. Brown* 97/129 *& G. Taaffe*; *J.M. Powell* 1363) have been made in the Eneabba area. No collections with mature fruit have been made from areas north of this area, which raises the possibility that ovoid fruit are the norm in the far north of the species' range. Fruit shape is very often a diagnostic character for species of *Styphelia* and the presence of two fruit shapes in *S. xerophylla* is potentially of taxonomic significance, even in the apparent absence of correlating characters. Further research and targeted fieldwork is required to clarify the morphological and geographical pattern of variation in fruit shape before proper consideration can be given to whether segregate taxa should be recognised.

Acknowledgements

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Elionurus tylophorus (Poaceae: Paniceae: Andropogoneae), a new species from the Kimberley region of Western Australia

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Abstract

Barrett, M.D. & Handasyde, T. *Elionurus tylophorus* (Poaceae: Paniceae: Andropogoneae), a new species from the Kimberley region of Western Australia. *Nuytsia* 30: 177–194 (2019). A new annual species, *Elionurus tylophorus* M.D.Barrett & T.Handasyde, is described in the genus *Elionurus* Willd. of the grass tribe Andropogoneae. It differs from all previously described *Elionurus* species in having keels of the lower fertile glumes ornamented with projections, these often terminated by minute solitary bristles, rather than regular cilia lacking projections, or with projections terminated by hair-tufts in other species. It differs further from *E. citreus* (R.Br.) Benth. and *E. purpureus* E.J.Thomps., the only other Australian *Elionurus*, in having strongly developed fertile glume nerves, rachilla longer and lacking a wing, and presence of lemmas and anthers in the pedicellate spikelet. *Elionurus tylophorus* is currently known from a single location in the King Leopold Ranges in the central Kimberley region, and has conservation significance. A primary division of *Elionurus* into two clades is hypothesised based on a preliminary chloroplast gene phylogeny and two morphological synapomorphies, presence of tufted glume hairs and oil streaks.

Introduction

The purpose of this paper is to describe a previously unknown species of *Elionurus* Willd. that was recently discovered in tropical Australia. The genus *Elionurus* belongs to the largely tropical Poaceae tribe Andropogoneae Dumort. and contains 16 species (Renvoise 1978; Kellogg 2015; Thompson 2017) distributed through Africa, the Arabian Peninsula, India and the Americas, with two disjunct species, *E. citreus* (R.Br.) Benth. and *E. purpureus* E.J.Thomps., occurring in tropical Australia and Papua New Guinea (Thompson 2017). *Elionurus* is absent from south-east Asia, the closest records to Australia being in the Middle East and India.

Elionurus belongs to the distinctive tribe Andropogoneae of subfamily Panicoideae Link, and shares the dominant tribal characters of paired spikelets (one fertile and sessile, the other pedicellate and usually sterile or staminate), disarticulating rachis and C4 photosynthesis (Kellogg 2015). Most species of Andropogoneae have twisted and hygroscopic lemma awns (possibly an apomorphy for the core Andropogoneae), but *Elionurus* is one of the few Andropogoneae genera to lack lemma awns. Although

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molecular phylogenies (e.g. Skendzic *et al.* 2007; Teerawatananon *et al.* 2011) strongly support *Elionurus* as a member of the Andropogoneae, the relationship of *Elionurus* within the tribe is uncertain and it is unplaced to subtribe in Kellogg (2015) and treated as Andropogoneae incertae sedis. Soreng *et al.* (2017), in their phylogenetic classification of Poaceae, place *Elionurus* in subtribe Tripsacinae Dumort., but many aberrant species of basal Andropogoneae have not yet been sequenced. It should be noted that a significant proportion of species and genera of tribe Andropogoneae are of allopolyploid origin and are difficult to treat in a hierarchical classification based on the principal of monophyly (Estep *et al.* 2014), but *Elionurus* species have not been investigated for allopolyploid origins.

Thompson (2017) provided a detailed discussion of morphological relationships with other genera and identified the presence of a proximal beak on the sessile spikelet as a key distinguishing character for *Elionurus*, which amongst the candidate close relatives is shared only with *Urelytrum* Hack. Most *Elionurus* species can also be identified to genus by the presence of one or two oil streaks on the lower glumes, but this is lacking in three species (Thompson 2017). Important morphological characters delimiting *Elionurus* from other Andropogoneae genera (following Kellogg 2015; Thompson 2017) are: inflorescences unbranched above final leaf blade, rachis fragmenting at maturity, spikelets paired with one sessile and fertile, the other pedicellate and sterile or male, (lower) glume coriaceous to indurated and thicker than the lemmas, fertile spikelets dorsiventrally compressed, lower glume of sessile spikelet with a bifid apex and two distant keels adjacent to an oil streak (streak absent in three species) and with cilia in lines or tufts along at least part of the keel, lemmas lacking awns, and both paleas absent. Most but not all species of *Elionurus* have two distinctive lobes or awns at the apex of the lower glume.

Elionurus citreus is a perennial (or sometimes annual?) species that occurs in tropical and subtropical Australia from the Kimberley to Queensland and south to New South Wales, and also in southern Papua New Guinea (Simon 1992; Simon & Alfonso 2011–). *Elionurus citreus* was considered the only Australian representative of the genus until Thompson (2017) described *E. purpureus*, an annual species known only from Cape York in Queensland. Some *Elionurus* species (e.g. *E. elegans* Kunth) have been characterised for the scent-producing volatiles. The Australian species *E. citreus* and *E. purpureus* have lemon-scented foliage and are known as Lemon Grasses or Lemon-scented Grasses.

In 2004, during a Department of Conservation and Land Management and Tropical Savannas Cooperative Research Centre survey in the King Leopold Ranges area of the Kimberley region of Western Australia (Start *et al.* 2012), an unusual grass was collected at one of the survey sites by T. Handasyde (TH). The specimen could not be confidently placed to genus, so it was sent to M. Lazarides in Canberra who suggested further material would be required to determine the genus. Subsequently, TH organised collection of further material from the same site in 2015 and 2017. Examination of both collections by M. Barrett (MB) confirmed that the material belonged to the genus *Elionurus*, possessing all the diagnostic characters of the genus as described above; however, the King Leopold specimens could not be accommodated in any known species (reviewed by Renvoise 1978 and Thompson 2017). It is therefore described below as a new species, *E. tylophorus* M.D.Barrett & T.Handasyde.

Methods

Morphology

Gross morphology of four accessions of *E. tylophorus* held at PERTH, including the proposed type, were examined in detail. Images of the types of *E. citreus* and *E. purpureus* were examined, as were all *E. citreus* collections held at PERTH and DNA.

DNA sequencing

In order to place the new species phylogenetically, DNA sequences were generated for two chloroplast regions, *ndh*F and *trn*K intron (including the *mat*K gene), and one nuclear rRNA region, the internal transcribed spacer (ITS), from the holotype specimen of *E. tylophorus*. All available *Elionurus* sequences from these regions were downloaded from GenBank, along with a range of outgroups from the tribe Andropogoneae (Table 1).

Extraction of genomic DNA was performed using a method modified from Doyle and Dickson (1987). The Carlson extraction buffer (Csaikl *et al.* 1998) contained 2% cetyltrimethylammonium bromide (CTAB), 1% polyethylene glycol (PEG), 1.4 M NaCl, 100 mM Tris-HCl and 20 mM EDTA (diluted from 0.5M pH 9.5 stock). Approximately 0.1 g of tissue was ground in 1 mL of buffer with 3 µL of 100 mg/mL RNase (Qiagen, Melbourne, Victoria, Australia) added before being incubated at 65°C for 15 mins. Samples were then centrifuged at 11,500 rpm for 10 mins, and the supernatant transferred to a new tube, with 1 vol. of chloroform: isoamyl alcohol (24:1) added before being shaken for 30 mins. After centrifuging at 9,000 rpm for 10 mins, DNA was precipitated from the supernatant by adding 1 vol. of cold (-20°C) isopropanol to each sample and stored at -20°C in a freezer for 20 mins before pelleting the DNA in a centrifuge at 13,000 for 10 mins. The pellet was then washed in 500 µL of 70% ethanol, re-centrifuged at 13,000 for 10 mins, and air-dried after removal of the ethanol.

Polymerase chain reactions (PCR) were performed on an Applied Biosystems Veriti® thermocycler, under the following conditions: 95°C for 3 mins, 37 cycles of ((95°C for 30 s, 48°C for 30 s, 72°C for 1.5 mins), 72°C for 10 mins). PCR amplifications were performed in 20 µL volumes, and consisted of a final concentration of 67 mM Tris-HCl (pH 8.8 at 25°C), 16.6 mM $(NH_4)_2SO_4$, 0.45% Triton X-100, 0.2 mg/mL gelatin, 0.2 mM of each dNTP (all diluted 1:4 from 5× polymerisation buffer, Fischer Biotec, Subiaco, Western Australia), 2.5 mM $MgCl_2$, 0.12% v/v DMSO, 0.06% v/v BSA, and 0.2 units Taq DNA polymerase (Fischer Biotec, Subiaco, Western Australia), 0.5 µM final concentration of each primer per reaction and *c.* 10–500 ng of template DNA. Primers used for DNA sequences were: ITS – 18SF / 26SR (Prince 2010); *mat*K – trnKmatKF / 2545R (Aliscioni *et al.* 2012); *ndh*F – 1311F / 2091R (Peterson *et al.* 2010).

Cycle sequence reactions were done using BigDye® Terminator v. 3.1 chemistry (Applied Biosystems) with the same primers as used for the PCR reaction, in both the forward and reverse directions, using the following PCR protocol: 96°C for 1 min, 25 cycles of (96°C for 10 s, 50°C for 5 s, 60°C for 4 min). Fragment visualisation was performed using an Applied Biosystems 3500 Genetic Analyser. Chromatograms were manually edited using CodonCode Aligner v.7.0.1 (CodonCode Corporation, Dedham, MA, USA, http://www.codoncode.com/). Comparisons to other sequences were made following alignment with sequences downloaded from GenBank (http://www.ncbi.nlm.nih.gov/) in the sequence database software Geneious® v.6.1.7 (http://www.geneious.com/; Kearse *et al.* 2012).

Phylogenetic analyses were performed separately for (1) a concatenation of *ndh*F and *trn*K intron (including the *mat*K gene) and (2) ITS, since the corresponding regions were only available for the same *Elionurus* sample in a few cases (Table 1). Outgroups were chosen to represent several different groups of Andropogoneae, since no close relatives of *Elionurus* have been identified in phylogenies. Phylogenetic trees were reconstructed using RAxML (Stamatakis 2014), using a rapid bootstrapping and search algorithm, with 100 bootstrap replicates and a GTR+GAMMA nucleotide substitution model, as implemented in Geneious® v.6.1.7 (http://www.geneious.com/; Kearse *et al.* 2012).

Table 1. Sequences used for phylogenetic analyses and GenBank numbers. Samples in bold were generated for this study.

Species	Voucher	ndhF	trnK / matK	ITS	Reference
Chrysopogon gryllus	*P.I. Kellogg* 250984 (A) (Rep. of Macedonia)	KY596161	KY596161[a]		Arthan *et al.* (2017)
	O. Neamsuvan 165 (BCU)			GQ856347	Neamsuvan *et al.* (unpublished)
Elionurus citreus	*S.J. & T.R. Hodkinson* 9561 (TCD) (Australia)	HE573560	HE574449	GQ870207	Aliscioni *et al.* (2012); Teerawatananon *et al.* 2011
	K.R. McDonald KRM 14437 (BRI AQ914411) (Australia)			**MK396908**	**This paper**
	K.R. McDonald KRM 15855 (BRI AQ915512) (Australia)			**MK396910**	**This paper**
Elionurus muticus	*J.M. Kimeu et al.* JMK 145 (EA, K) (Kenya)	MF998637	MF998984		Hackel *et al.* (2018)
	Not specified			AF190758	Spies & Kellogg (unpublished)
Elionurus purpureus	*P.I. Forster* PIF 45151 (BRI AQ941416) (Australia)			**MK396909**	**This paper**
Elionurus royleanus	*M.S. Vorontsova et al.* MSV 826 (EA, K) (Kenya)	MF998646	MF998985		Hackel *et al.* (2018)
Elionurus tripsacoides	*Manrique* 1895 (COCA) (Mexico)			DQ005046	Skendzic *et al.* (2007)
Elionurus tripsacoides	*Manrique* 1904 (COCA) (Mexico)			DQ005047	Skendzic *et al.* (2007)

Species	Voucher	ndhF	trnK / matK	ITS	Reference
Elionurus tristis	*M.S. Vorontsova et al.* MSV 589 (K, TAN) (Madagascar)	LN908091	LN906693		Hackel *et al.* (2018)
Elionurus tylophorus	*T. Sonneman* TH 8073 (PERTH, holotype) (Australia)	**MK097174**	**MK097175**	**MK095935**	**This paper**
Hemisorghum mekongense	*Traiperm* 569 (BKF) (Thailand)	KY596132	KY596132[a]		Arthan *et al.* (2017)
Miscanthus transmorrisonensis	Not specified	LN869229	LN869229[a]		Lloyd & Joshi (unpublished)
	Hodkinson 20 (K)			AY116271	Hodkinson *et al.* (2002)
Themeda villosa	*Arthan* 065, (BKF) (Thailand)	KY596131	KY596131[a]		Arthan *et al.* (2017)
	E00697528 (China)			KY991079	Dunning *et al.* (2017)
Tripsacum dactyloides	Not specified (China)	NC_037087	NC_037087[a]		Wang *et al.* (2017)
	Sanchez-Ken 607 (ISC) (Mexico)			DQ005086	Skendzic *et al.* (2007)

[a] Extracted from a plastid genome, hence *ndh*F and *trn*K / *mat*K have the same accession number.

Results

The chloroplast RAxML tree (Figure 1A) supported the monophyly of all sampled *Elionurus* species (100% bootstrap (BS) support). *Elionurus royleanus* A.Rich. was recovered as sister to all remaining species, but with low support (70% bootstrap, hereafter BS) support. Within the core *Elionurus* clade resolution was poor, and only a sister relationship between *E. muticus* (Spreng.) Kunth and *E. tristis* Hack. was supported (82%).

In the ITS RAxML tree (Figure 1B), *Elionurus* was not recovered as monophyletic due to the unresolved position of the single *E. muticus* sample. The *E. muticus* sample is very divergent from all other ITS sequences, and is likely a misidentified or contaminated sample, given that a different specimen of *E. muticus* is placed within the core *Elionurus* clade on chloroplast data. A clade containing all remaining *Elionurus* samples was strongly supported (100% BS), in the ITS tree, and divided into two sub-clades, one containing the two *E. tripsacoides* Kunth samples (100% BS), the other clade containing *E. tylophorus* sister to *E. citreus* (77% BS).

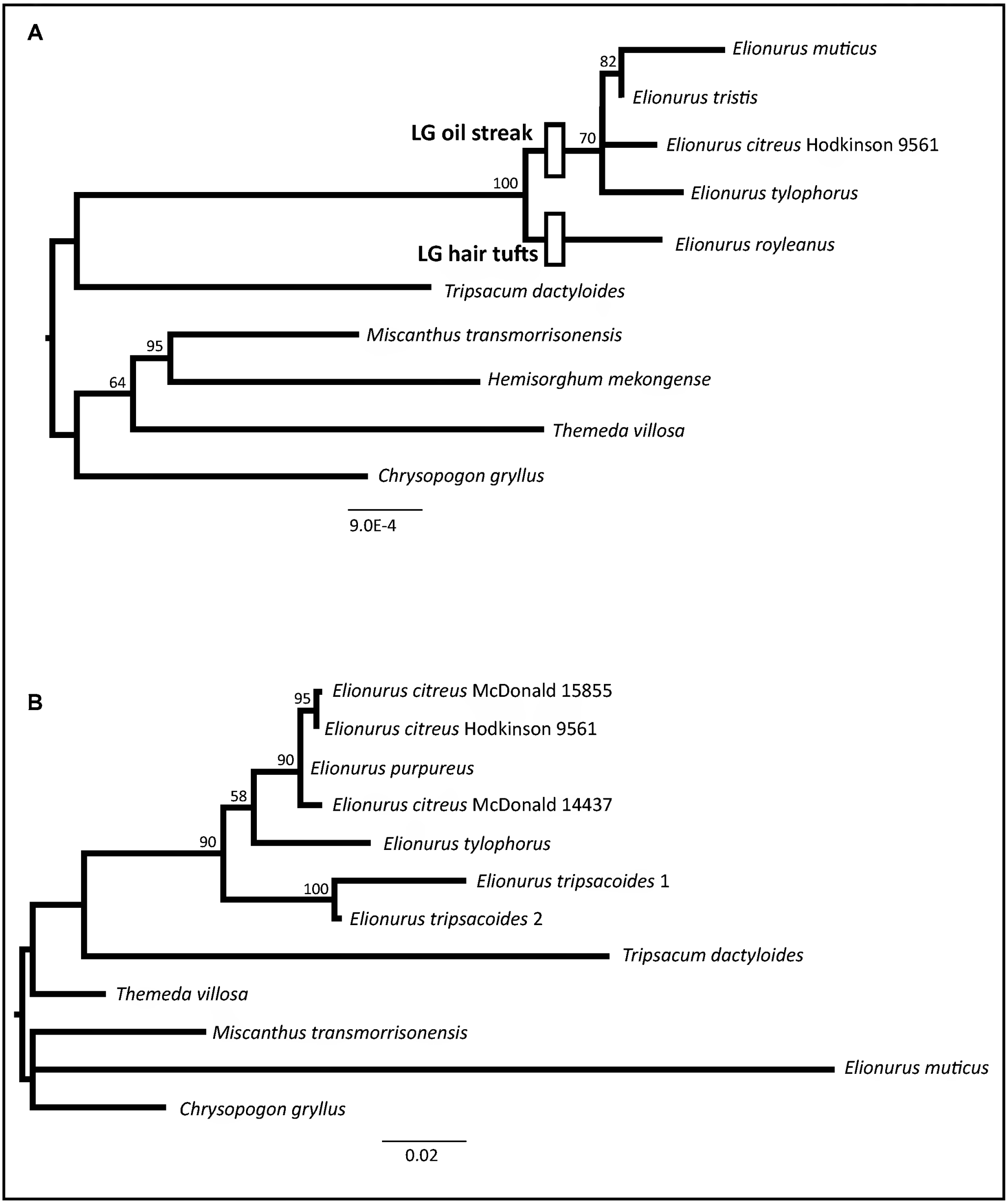

Figure 1. Phylogenies of *Elionurus* based on chloroplast and nuclear sequences. A – phylogenetic tree of ten chloroplast *ndh*F and *trn*K-intron sequences showing the monophyly of *Elionurus* and sister relationship of *E. royleanus* and all other *Elionurus* species; the position of two potential apomorphies for basal sister clades of *Elionurus* are indicated; B – phylogenetic tree of twelve ITS sequences showing the monophyly of *Elionurus*, a well-supported *E. citreus* / *E. purpureus* clade, and variation between *E. citreus* samples. See text for further discussion.

Discussion

Morphological comparison and evidence for a new species

A detailed summary of key features of the *Elionurus* collections are listed in Table 2. From this data, there are numerous discrete differences to both *E. citreus* and *E. purpureus*, spread across all parts of the plant. Thompson (2017) identified several apparently apomorphic features that unite the Australian species *E. citreus* and *E. purpureus*: pedicellate spikelets neuter (lacking anthers), and rachillas chartaceous, inflated and usually with a distal, bilobed flange. In comparison, all other *Elionurus* species, including *E. tylophorus* have male pedicellate spikelets and cartilaginous, slender rachillas lacking a flange. *Elionurus tylophorus* therefore is expected to lie outside of a presumed *E. citreus*+*E. purpureus* clade, but with unknown affinities to extra-Australian species.

Elionurus tylophorus can be accommodated in the Appendix 2 table of Thompson (2017) comparing all species of *Elionurus*, by listing the following character states: *paired spikelets* dissimilar; *sessile spikelet*: lower glume margin hairs pectinate (but the lower ones tubercle-based, resembling the tufted condition but with only a single apical hair); lower glume submargins with an oil streak; lower glume apex attenuate and 2-lobed; *pedicellate spikelet*: floret male; lower glume asymmetrical; lower glume margins with an oil streak on both margins; lower glume margins 2-keeled; lower glume apex long-attenuate, 1-lobed/awned. This combination of characters is unique, but most similar to *E. hensii* K.Schum. and *E. muticus*. *Elionurus hensii* shares with *E. tylophorus* the annual habit (according to Renvoise (1978), although Clayton *et al.* (2018) describe it as perennial), but differs in having smaller spikelets 3–4 mm long. *Elionurus muticus* is a perennial with short rhizomes and mostly basal leaves, and has spikelets in a pair similar to each other, while *E. tylophorus* is annual with cauline leaves and spikelets in a pair dissimilar.

The projections on the margins of the lower glume of the sessile spikelet of *E. tylophorus* are found in three other species, *E. elegans*, *E. hirtifolius* Hack. and *E. royleanus* (Renvoise 1978; Thompson 2017 Figure A3.1, A3.2), which might possibly indicate a relationship. However, these species all have tufts of hair on the submarginal projections of the sessile spikelet lower glumes, lack oil streaks on the glumes and have 1-keeled lower glume of the pedicellate spikelet. In contrast, *E. tylophorus* has submarginal projections of the sessile spikelet lower glumes with at most a single hair, lower glumes of both sessile and pedicellate spikelets with two oil streaks, and lower glume of the pedicellate spikelet 2-keeled.

E. tylophorus therefore differs in multiple characters from all described species of the genus, indicating that species rank is appropriate for the new taxon. Keys are provided below to *Elionurus* in Australia, and to place *E. tylophorus* within the global key of Renvoise (1987). Different characteristics of *E. tylophorus* weakly suggest relationships with various other species in the genus, and true affinities will require molecular data.

Key to Australian species of *Elionurus*

1. Keels (submarginal) of lower glume of sessile spikelet with a row of prominent projections often terminated by a single minute bristle, the projections grading into long cilia near glume apex; rachilla not winged at apex; pedicellate spikelet with lemmas and anthers .... **E. tylophorus**

1: Keels (submarginal) of lower glumes of sessile spikelet pectinate (regularly ciliate), lacking projections; rachilla usually winged at apex; pedicellate spikelet lacking lemmas and anthers **2**

2. Annual; sessile spikelet 8.1–9.2 mm long; lower glume of sessile spikelet with lobes shorter than body, purple at maturity; lower and upper glumes of pedicellate spikelet 5-veined .... **E. purpureus**

2: Perennial; sessile spikelet 10.6–13.1 mm long; lower glume of sessile spikelet with lobes longer than body, pallid to pale pink, rarely purplish; lower and upper glumes of pedicellate spikelet 3-veined .... **E. citreus**

Elionurus tylophorus can be included in the global key to *Elionurus* species of Renvoise (1978) by adding the following couplet at the start of the key (see Thompson (2017) for the addition of *E. purpureus* to the Renvoise (1978) key):

1. Keels (submarginal) of lower glume of fertile spikelet with a row of prominent projections, glabrous or terminated by a single minute bristle, the projections grading into long cilia near glume apex .... **E. tylophorus**

1: Keels (submarginal) of lower glumes of fertile spikelet with longer cilia either regularly arranged and lacking projections, or if with projections these terminated by hairs in tufts .... **Go to step 1 in Renvoise (1978)**

Table 2. Distinguishing morphological characters between the three Australian *Elionurus* species (after Thompson 2017).

Character	*Elionurus citreus*	*Elionurus purpureus*	*Elionurus tylophorus*
Growth habit	perennial (or occasionally annual according to collector notes and herbarium specimens)	annual	annual
Inflorescence type	single racemes at nodes on cultivated plant and topotypes	multiple racemes at nodes at least on cultivated plants	multiple racemes at nodes on wild-collected plants
Culms (shape in T.S.)	narrowly convexo-concave	broadly convexo-concave	broadly convexo-concave
Leaf blades and sheath			
Distribution	mostly basal	cauline	cauline
Margin prickle hairs	medium (60–70 um)	absent	present, to 1.5 mm long
Margins and mid-vein indumentum	usually scabrous	smooth	smooth
Mid-vein	acutely keeled	obtusely keeled	±obtusely keeled
Sessile spikelet (mid-raceme)			
Total length (beak, body and lobes) (mm)	10.6–12.1	8.1–9.2	9.0–13.2
Colour at maturity	pallid to pale pink, rarely purplish	purple	green turning straw with purplish margins or pale purplish all over
Lower glume			
lobe length (mm)	5.5–7	2.6–3.2	2.0–4.5

Character	*Elionurus citreus*	*Elionurus purpureus*	*Elionurus tylophorus*
body width × length (mm)	1.5–1.7 × 3.6–4.3	1.7–2.0 × 3.5–4.2	1.4–2.0 × 7.0–12.0
texture	cartilaginous	chartaceous	cartilaginous
nerve prominence	not raised	not raised	strongly raised
indumentum type	glabrous to pilose	pubescent	pubescent in rows between nerves
orientation	ascending	appressed	ascending (appressed)
hair length (mm)	*c.* 2	*c.* 0.2	0.05–0.25
keeled margins	narrowly winged	not winged	very narrowly winged
Upper lemma			
margin texture	hyaline	hyaline	pale straw
marginal indumentum	ciliate apically or glabrous	pilose	±sparely ciliate
apex	attenuate	acute	attenuate
Callus length (mm)	1.8–2.7	1.0–2.3	1.5–2.5
Pedicellate spikelet			
Lower glume			
width × length (mm)	*c.* 0.9 × 7.2–8.5	0.8–1.3 × 5.2–5.7	0.8–1.2 × 9–11.7
colour at maturity	pallid to pale pink, rarely purplish	purple	green turning straw with purplish margins or pale purplish all over
body	linear to narrow lanceolate	lanceolate	lanceolate to narrowly lanceolate
	asymmetrical	asymmetrical	asymmetrical
	3-veined	5-veined	7-veined
	1-keeled	1-keeled	2-keeled
	one margin with oil streak	both margins with oil streak	both margins with oil-streak
Upper glume	unequal to lower glume	subequal to lower glume	subequal to lower glume
veins	3-veined	5-veined	obscurely 3–5-nerved
shape in section	laterally compressed	rounded	rounded to laterally compressed
Lemmas	absent	absent	present
Anthers	absent	absent	present
Anther length			
Chasmogamous (mm)	1.3–2.7	0.9–2.0	2.5–3.0
Cleistogamous (mm)	0.7–1.8	*c.* 0.8	not seen
Pedicellate floret	absent	absent	2.2–3.8
Rachilla			
Width × length (mm)	0.9–1.3 × 3.3–5	1.2–1.4 × 4.3–4.4	0.9–1.2 × 7.5–16,
Shape	clavate	distinctly clavate	parallel-sided

Character	*Elionurus citreus*	*Elionurus purpureus*	*Elionurus tylophorus*
Apex rim	usually narrowly winged and unequally bilobed, or not winged	distinctly winged, unequally bilobed	entire, not winged, not bilobed
Subapical beard length of longest hairs (mm)	3.6–4.9	2.8–2.9	2.5–4.5
Pedicel			
Width × length (mm)	0.5–0.6 × 2.9–4.0	*c.* 0.8 × 2.5–3.5	0.6–0.8 × 4.1–6.2

Phylogeny of Elionurus

In the chloroplast *ndh*F + *trn*K tree (Figure 1A), *E. royleanus* was found sister (70% BS) to all other *Elionurus* species, including *E. tylophorus*. *Elionurus royleanus* was the only sampled representative of three similar species with tufted hairs on the submargins of the lower glume of the sessile spikelet (the others being *E. elegans* and *E. hirtifolius*, hereafter the 'tufted group'). These unique hair-tufts, along with other similarities (see Appendix 2 in Thompson 2017) suggest that the 'tufted group' might be a monophyletic clade sister to the remaining 'core group' of *Elionurus*; if so the presence of 1 or 2 oil streaks on the lower glumes would then be an apomorphy for the 'core group' (oil streaks are lacking in the 'tufted group'; Thompson 2017). The presence of glume hair tufts and oil streaks might then be reciprocal apomorphies for a primary dichotomy within *Elionurus*. The position of *E. tylophorus* remote from *E. royleanus* suggests that the tuberculate projections on lateral submargins of the lower glume of the sessile spikelet found in the 'tufted group' and *E. tylophorus* are not indicative of a close relationship, but instead arose through convergence or homoplasy. The relationship between *E. tylophorus* and *E. citreus* was insufficiently resolved, and too many potentially intermediate species remain unsampled, to draw any conclusions about the monophyly or otherwise of Australian *Elionurus* from the chloroplast data.

In the ITS tree (Figure 1B), the available samples of *Elionurus* are supported (90% BS) as a monophyletic group, however no species of the 'tufted group' discussed above have ITS sequences available. A clade composed of the three representatives of *E. citreus* and one *E. purpureus* was strongly supported (90% BS), to the exclusion of *E. tylophorus*. This *E. citreus* clade is in agreement with the morphological evidence presented in Thompson (2017) for a close relationship between *E. citreus* and *E. purpureus*, and also corroborates the distinctiveness of *E. tylophorus* from the other Australian species. Two of the *E. citreus* specimens (*K.R. McDonald* 15855 and *S.J. & T.R. Hodkinson* 9561) formed a strongly supported clade (95% BS) and were divergent from the third specimen of *E. citreus* (*K.R. McDonald* 14437), which formed a polytomy with the sample of *E. purpureus*. This result suggests that *E. citreus* might not be monophyletic with the separation of *E. purpureus*. The specimens *K.R. McDonald* 15855 and *K.R. McDonald* 14437 had been annotated as belonging to 'small spikelet' and 'long spikelet' forms respectively, which could indicate a morphological difference between them. The ITS data therefore argue for further taxonomic revision of *E. citreus* across its range. Although a sister relationship was recovered between the *E. citreus* – *E. purpureus* clade and *E. tylophorus*, it was poorly supported (58% BS). Since *E. tripsacoides* is the only non-Australian species for which ITS sequences are available, it is not yet possible to draw any conclusions about the monophyly or otherwise of the Australian species. The ITS sequence generated for *E. tylophorus* differs in 18–21 substitutions plus several indels (95% similarity) from the sequences of *E. citreus*, which is considerably greater than is typically observed between closely related grass species (only 3 or 4 substitutions between *E. purpureus* and the various *E. citreus* sequences). The number of substitutions between *E. tylophorus* and *E. citreus* is comparable

to the difference between *E. tylophorus* and a Mexican accession of *E. tripsacoides* (DQ005047, Skendzic *et al.* 2007; 20 substitutions plus several indels, 94% similarity). The Australian *E. citreus* – *E. purpureus* clade and *E. tylophorus* therefore seem to be relatively distantly related to each other. Greater sampling of ITS and other loci within *Elionurus* will be required to determine whether the two Australian lineages arose following independent dispersals into Australia or represent a single more ancient lineage that speciated within Australia.

The apparent restricted distribution of *E. tylophorus* is puzzling, given that its habitat is unassuming, appears representative of a widespread soil type and plant community, and is not obviously linked to any localised geological or hydrological feature (Figure 2). Many grass species in the Australian Monsoon Tropics have wide distributions, often extending to south-west Asia or beyond; however, occasional species with apparently restricted distributions do exist (e.g. *Clausospicula extensa*, a restricted monotypic genus in the Top End, Lazarides *et al.* 1991). It is possible that *E. tylophorus* has simply been overlooked amongst the array of other co-occurring grasses and is in fact more widespread than current data suggests.

Taxonomy

Elionurus tylophorus M.D.Barrett & T.Handasyde, *sp. nov.*

Type: King Leopold Ranges, Western Australia [precise locality withheld for conservation reasons], 13 April 2015, *T. Sonneman* TH 8073 (*holo*: PERTH 08662908; *iso*: BRI, K, PERTH 09033955 (smutted specimen)).

Erect *annual* grass 45–60 cm tall; *culms* <4 mm wide, unbranched, green to reddish; *nodes* 4–8, glabrous, *internodes* purplish, ±terete near base, broadly convexo-concave (±D-shaped) above, mostly glabrous but just below inflorescence-subtending node with appressed hairs along the angles, hairs becoming longer (up to 4.5 mm long) just below the node. *Ligule* a dense fringe of hairs 0.7–2.5 mm long. *Leaves cauline*; *leaf sheath* 26–52 mm long, 9–23-nerved, glabrous or sparsely hispid near *apex*; *leaf blades* linear, flat to canaliculate or involute, 65–175 mm long, 0.7–2.5 mm wide, 9–11-nerved, ±rounded on the abaxial surface but with raised nerves that are sometimes ±acute, adaxial surface glabrous to sparsely hispid near the base, abaxial surface glabrous except for the submargins with sparse tubercles often terminated by a stiff hair up to 1.5 mm long. *Inflorescence* a spatheolate raceme but appearance spiciform, racemes in upper 1–3 nodes. *Spatheoles* 45–69 mm long, mostly tightly sheathing and obscure, with a small, erect blade enclosing only the base or sometimes to apex of the lowest spikelet at maturity. *Racemes* 1–7 per node, 35–75 mm long, 3–8 mm wide, of 4–12 spikelet-pairs; *rachis* fragmenting at maturity, *rachillas* free from the internode, dissimilar to pedicel, shorter than or longer than pedicels, 7.5–16.0 mm long (tip to tip), 0.9–1.2 mm thick at widest point, ±parallel-sided, hollow, oblique at joints leaving sharply acute apices, somewhat flattened in section, mostly glabrous to very sparsely minutely to shortly hairy, but abaxial edge densely shortly hairy in a broad band with hairs ascending, 0.7–1.0 mm long, with longer stiff white hairs at apex, the longest hairs 3.0–4.5 mm long; apex oblique, not winged or bilobed; disarticulation scar flattened, rim thickened, glabrous. *Spikelets* paired, one sessile and fertile, the other pedicellate and sterile, dimorphic within the pair, not gradational (similar length along the raceme), appressed and closely overlapping in two opposed staggered rows along a jointed disarticulating axis; diaspore composed of a pair of spikelets remaining attached to the rachilla. *Sessile spikelet* containing 2 florets, the lower sterile, the upper bisexual, apparently always chasmogamous, 9.0–13.2 mm long (including callus and proximal beak), 1.4–2.0 mm wide, dorsiventrally compressed; *proximal beak c.* 1.4–1.8 mm long, glabrous or hairy along margins and gradually merging with callus; *callus* elliptic, *c.* 1.0–1.5 mm long, gradually

merging with beak, apex moderately acute to obtuse in face view, sharply acute in side view, glabrous along broad midline, pubescent with white hairs to 0.8–1.2 mm long on lateral faces, green turning straw sometimes with purplish margins or pale purplish all over; *glumes* dissimilar; *lower glume* of sessile spikelet 7–12 mm long (excluding callus), 1.4–2.0 mm wide, oblong to ±elliptic, broadest near the middle, apex bifid with 2 long beak-like teeth each 2.0–4.5 mm long (much shorter than glume body), body thickly indurated, prominently 6–8-veined with thickened raised veins, strongly 2-keeled (keels thickened, sub-marginal and highly divergent, with nerves between them), body with sparse ±appressed to pubescent white hairs 0.05–0.25 mm long in lines in the narrow grooves between nerves, the grooves narrower than the nerves, a narrow, pale reddish brown oil streak present just inside each of the keels in the basal half (extending onto the inner face); keel not winged, with a row of strong tuberculate projections 0.15–0.3 mm tall in the lower 1/2–4/5 of the body, projections rounded to acute containing a single oblique apical hair up to 0.5 mm long, gradually merging into a dense fringe of stiff white hairs on keel margin (the longest hairs 0.5–0.8 mm long); glume margins very narrow, ±membranous, entire, slightly in-rolled beyond the keels and difficult to observe; *upper glume* of sessile spikelet 7–8 mm long, 1.7–2.0 mm wide, narrowly 1-keeled (carinate), 3-veined, shortly acuminate, chartaceous to coriaceous in the inner part between the nerves, membranous to chartaceous marginally outside the lateral nerves, shortly hairy (0.05–0.4 mm, irregular orientation, ascending) in a band either side of the keel and including on the keel, glabrous on marginal areas, narrow membranous margins with sparse to moderately sparse cilia (0.2–0.4 mm, wavy) in upper half; *lower lemma* of sessile spikelet 4.2–4.7 mm long, *c.* 1.4 mm wide, lanceolate, acute, lacking nerves or obscurely 2–4-nerved near base, membranous, pale straw to pale brown near base, sub-hyaline above and on margins, glabrous or minutely ciliate on upper margins; *upper lemma* of sessile spikelet elliptic, 4.2–4.6 mm long, *c.* 1.3 mm wide, lanceolate, acute to acuminate, membranous to chartaceous, pale straw to sub-hyaline, 0-nerved or obscurely to moderately 3-nerved, glabrous or with a few cilia *c.* 0.25 mm long in upper part; lower and upper *paleas* of sessile spikelet absent; *anthers* 3, *c.* 2.5–3.0 mm long, purple; *styles* 2, exserted at anthesis, purple; *caryopsis* 3.6–4.9 mm long, 1.0–1.1 mm wide, moderately to distinctly dorsiventrally compressed, hilum half as long as caryopsis; *lodicules* 2, *c.* 0.4 mm long, membranous, broadly rounded at apex, entire. *Pedicellate spikelet* 8.0–11.7 mm long (excluding pedicels), 2–8 mm wide, rounded to weakly dorsiventrally compressed, with two florets, the lower sterile and the upper functionally male (anther may be difficult to demonstrate in older specimens with dropped anthers) with 2 glumes and 2 lemmas, initially lanceolate but gaping at maturity; *pedicels* 4.1–6.2 mm long, 0.6–0.8 mm wide, glabrous on one face, the opposite 'external' face with a longitudinal curving arc of short hairs that terminates in a sub-apical tuft of hairs 2.5–4.5 mm long; *glumes* dissimilar; *lower glume* of pedicellate spikelet asymmetric most noticeable in keel indumentum, 9.0–11.7 mm long, 0.8–1.2 mm wide, dorsiventrally compressed, lanceolate to narrowly lanceolate, apex long-acuminate into an awn (2.0–)4.0–6.0 mm long, coriaceous, green to pale purplish all over, obscurely to moderately strongly 7-veined (not or scarcely raised, visible in transmitted light), 2-keeled close to margins, oil-streak present on both sides, with the keel glabrous or with stiff white hairs *c.* 0.2 mm long (indumentum usually asymmetric, more prominent on one keel than the other), margins membranous, 0.2–0.4 mm wide and wider on one side than the other; *upper glume* of pedicellate spikelet rounded to laterally compressed, shorter, subequal to or slightly shorter or longer than lower glume, very narrowly lanceolate, long-attenuate into an awn *c.* 3–5 mm long, indurated in central zone, chartaceous to membranous on sides, 1-keeled ±in centre, obscurely to moderately 3–5-nerved, scabrous along upper keel and margin, glabrous; *lower lemmas* of pedicellate spikelet 3.0–4.0 mm long, 0.8–0.9 mm wide, lanceolate, acute to muticous, chartaceous to membranous, not nerved, glabrous or with marginal cilia in upper part; *upper lemma* of pedicellate spikelet shorter than lower, 2.6–3.0 mm long, glabrous, otherwise similar to lower lemma; *paleas* absent; *anthers* present in upper floret, 3, apparently dimorphic, 2.2–3.8 mm long and exserted at maturity (a few 0.4 mm long are probably merely immature), purple; *ovary* and *styles* rudimentary, *c.* 0.2 mm long, not developing further. (Figure 3)

Diagnostic features. *Elionurus tylophorus* differs from all known *Elionurus* species in having keels (that are submarginal) of the lower fertile glumes ornamented with projections, which are often terminated by minute solitary bristles. Other notable features include: annual habit, prominently thickened lower glume nerves in the fertile (sessile) floret, pedicellate spikelets male with well-developed lemmas and anthers, lower glume body ±oblong with parallel-sided lateral outline, and glumes of the pedicellate spikelet subequal in length and awned.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] same locality as type, 29 May 2017, *K. Carnes* TH 8193 (DNA, KNR, PERTH); same locality as type, 26 May 2004, *T. Handasyde* TH 2148 (BRI, CANB, DNA, KNR, PERTH); same locality as type, 13 April 2015, *T. Sonneman* TH 8072 (PERTH).

Phenology. Fertile collections have been made between April and May (the latter senescing).

Distribution and habitat. The single known *E. tylophorus* population was growing on a rocky ridge/slope of colluvium and alluvium in a sparse low woodland of a mix of species including *Eucalyptus tectifica*, *E. brevifolia*, *Corymbia cadophora* and *Erythrophleum chlorostachys* over scattered *Cochlospermum fraseri* and *Calytrix achaeta* (Figure 2). Ground cover included sparse to moderately dense *Heteropogon contortus*, *Eriachne sulcata*, *Mnesithea rottboellioides* and *Cymbopogon bombycinus*. *Elionurus tylophorus* is currently known from a single location in a geologically diverse section of the King Leopold Ranges in the central Kimberley.

Figure 2. Habitat of *Elionurus tylophorus* from type location. Arrow indicates *E. tylophorus*, drying straw-coloured at time of photo.

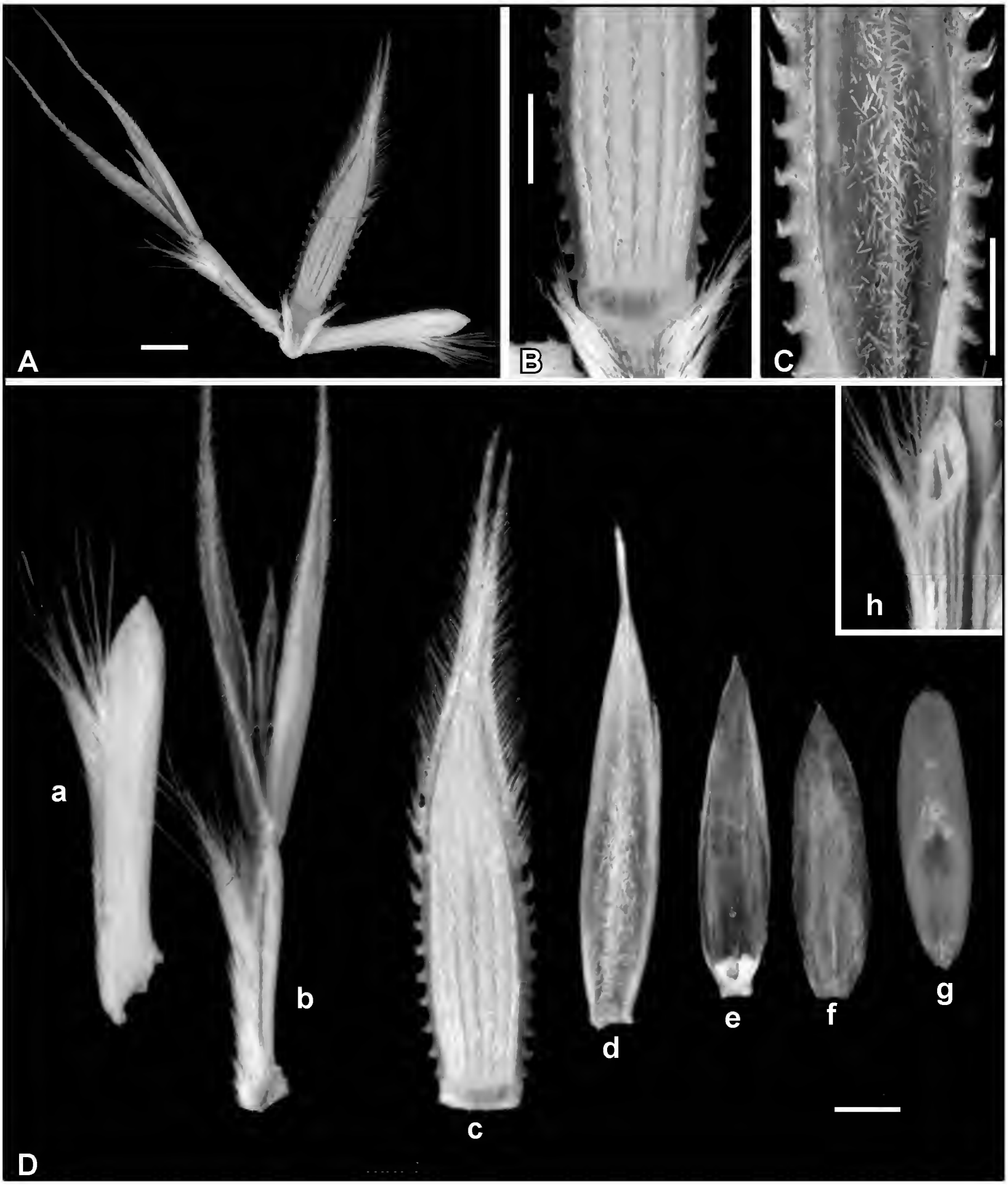

Figure 3. *Elionurus tylophorus* (*T. Sonneman* TH8073). A – splayed spikelet pair, showing pedicellate spikelet, fertile sessile spikelet and rachis internode; B – abaxial surface of base of lower glume of sessile spikelet showing strongly raised nerves, short hairs in rows between nerves, and marginal projections; C – adaxial surface of base of lower glume of sessile spikelet showing projections, and upper glume showing keel and surface hairs; D – dissected spikelet pair: a – rachilla, b – male pedicellate spikelet with lemmas visible, c – lower glume (with callus cut away), d – upper glume, e – lower lemma, f – upper lemma, g – caryopsis, h (insert) – apex of rachilla, which lacks a wing and is not bilobed. All scale bars 1 mm.

Conservation status. To be listed as Priority Two under Conservation Codes for Western Australian Flora (M. Smith, pers. comm.). It is conserved in the King Leopold Ranges Conservation Park (previously Mt Hart Station).

Etymology. The species epithet is Greek from *tylo-* (with knobs, lumps or projections), and *-phorus* (-bearing).

Notes. Cleistogamous flowers have been reported in both of the other Australian species, *E. citreus* and *E. purpureus* (Thompson 2017), but were not detected in any of the three specimens of *E. tylophorus*. However, plants were not cultivated, and some of the available *E. tylophorus* material is over-mature. In the *K. Carnes* TH 8193 collection, the best racemes have styles that are exserted but have already exserted and dropped their anthers from all sessile florets, while the sterile florets all have exserted or dropped anthers. In this collection at least, it appears that cleistogamous flowers are lacking, the sessile flowers are protandrous (as in most grasses), while the styles of sessile spikelets are ±synchronous within a raceme and with anthers of the pedicellate spikelets.

Racemes in *Elionurus* fragment from the apex downward; although the lowermost spikelet is the last to fall in *E. tylophorus*, it does not appear tardily dehiscent as reported for *E. purpureus* (and at least one *E. citreus* plant) by Thompson (2017). Much of the available material is in the stage of dehiscing, and even prior to the secondmost-basal spikelet dehiscing the basal joint is already weak, suggesting that there is no significant delay of dehiscence of the basal florets.

The characteristic marginal projections on the lower fertile glumes of *E. tylophorus* are possibly developmentally homologous with tuberculate bases of hairs, as found on leaves in the same species, since the projection is frequently terminated by a single short hair. Alternatively, since the projections are tightly fused with the keel, they may be outgrowths of the keel itself, centred on hair-cells.

Elionurus tylophorus differs from all known *Elionurus* species (Renvoise 1978) in having submarginal projections on the keels of the lower fertile glumes, which are often terminated by minute solitary bristles, compared to cilia or hair-tufts that are not swollen at the base in other species. *Elionurus tylophorus* is also unusual within the genus in its annual habit. Aside from *E. purpureus* discussed above, the only other annuals or short-lived perennials in the genus are the African and Indian species *E. elegans*, *E. hensii* and *E. royleanus* (Renvoise 1978).

Elionurus tylophorus differs further from both of the only other Australian *Elionurus*, *E. citreus* (Figure 4) and *E. purpureus* (Thompson 2017), in its annual habit (usually tufted perennial in *E. citreus*), prominent thickened lower glume nerves in the fertile (sessile) floret (lower glume smooth or with thin scarcely raised nerves in *E. citreus*), lemmas and anthers present in pedicellate spikelets (absent in *E. citreus* and *E. purpureus*), lower glume body ±oblong with parallel-sided lateral outline (ovate and rounded lateral outline in *E. citreus* and *E. purpureus*), and glumes of the sterile spikelet roughly subequal in length (upper glume usually 1/2–2/3 as long as the lower glume in *E. citreus* and *E. purpureus*). Further differences between all three Australian species are contrasted in Table 2, and in the keys.

The leaves of *E. citreus* have a lemon scent when crushed, but only a weak scent from crushed inflorescences is reported for *E. tylophorus* (*K. Carnes* TH 8193).

Figure 4. *Elionurus citreus* (*G.N. Batianoff* 10118, PERTH 01780565, QLD, Lizard Is.), which is a good match for the holotype of *E. citreus* [*Andropogon citreus* R.Br.; *R. Brown* 6176, 1802; images of holotype at K and isotypes at E, W seen], except in being less obviously perennial than the type. A – splayed spikelet pair, showing sterile pedicellate spikelet, sessile spikelet and rachilla with expanded apex; B – base of lower glume showing obscure nerves, and marginal cilia (rachilla and pedicel cut away from callus); D – dissected spikelet pair: a – rachilla showing slightly winged and bilobed apex, b – sterile pedicellate spikelet, c – lower glume (with callus cut away), d – upper glume, e – lower lemma, f – upper lemma. All scale bars 1 mm.

Elionurus tylophorus superficially resembles some slender species of *Ischaemum* L. or *Sehima* Forssk., but is immediately distinguished by lacking an awn on the fertile lemma (twisted and geniculate awn present in *Ischaemum* and *Sehima*).

Two of the collections are smutted [*K. Carnes* TH 8193 (PERTH 08654972) and TH 8073 (PERTH 09033955)]. No smut has previously been reported on *Elionurus* from Australia (Shivas *et al.* 2014), but three species, *Anthracocystis elionuri* (Henn. & A.Evans) McTaggart & R.G.Shivas, *Macalpinomyces elionuri-tripsacoidis* Vánky and *Sporisorium elionuri-tristis* Vánky have been described from *Elionurus* in Africa (Vánky 1999, Vánky 2003; McTaggart *et al.* 2012a, b). Future work may show that the smut on *E. tylophorus* is an undescribed species, and if so may be rare along with its host.

The vernacular name Toothed Wire Grass is suggested.

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SHORT COMMUNICATION

A key to the species of *Thomasia* (Malvaceae: Byttnerioideae)

Thomasia J.Gay (Malvaceae Juss.) is predominantly Western Australian; only *T. petalocalyx* F.Muell. has populations that extend to South Australia and Victoria (AVH 2019). There are 31 formally named species in the genus with a further six potentially new phrase named taxa currently recognised (Western Australian Herbarium 1998–). Published information is limited as *Thomasia* has not been revised in full since Bentham's (1863) original *Flora Australiensis* treatment. Additionally, nearly half of all species are listed as priority taxa under the Conservation Codes for Western Australian Flora, with *T. glabripetala* S.J. Patrick, *T. montana* Steud. and *T.* sp. Green Hill (S. Paust 1322) recognised as Declared Rare Flora and *T. gardneri* Paust presumed to be extinct (Smith & Jones 2018). Finally, *T. triloba* Turcz. is currently only known from type material (*J. Drummond* 106: E00279375 image!; E00279376 image!; G00358699 image!; G00358700 image!; G00358701 image!; GH00061420 image!; K000686031!; K000686032!; K000686033!; KW001000146 image!; MEL1539808 image!; MEL723992 image!; NSW386401!; TCD0010921 image!) (Figure 1). The original location of this species is uncertain and while it currently has a Priority One conservation status it has never been recollected and so may also be extinct.

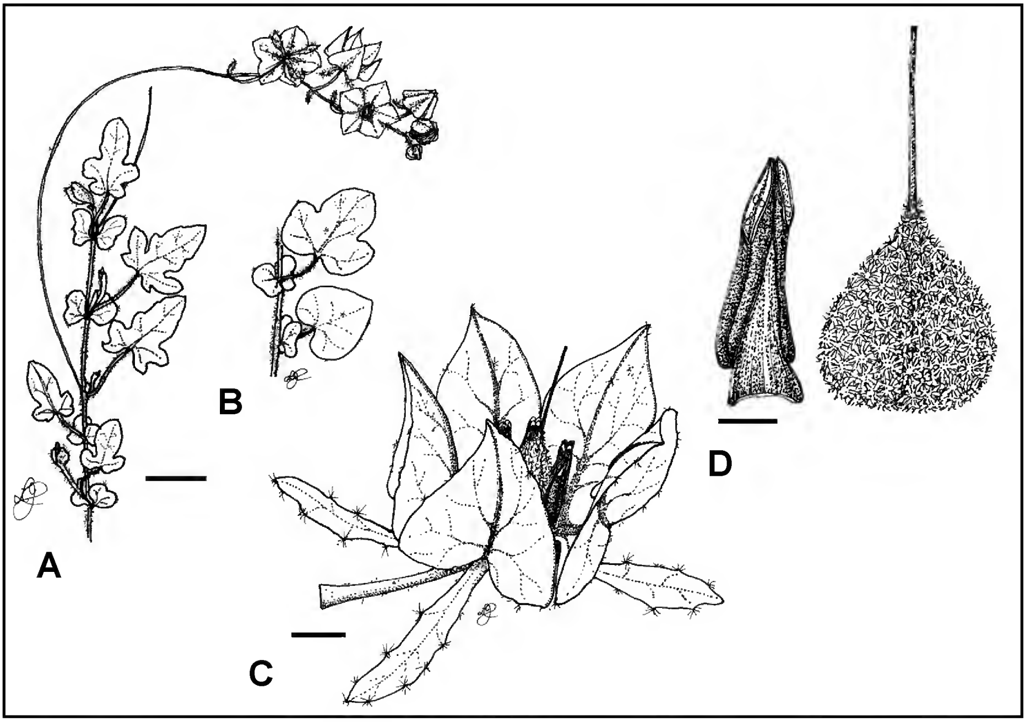

Figure 1. Illustration of *Thomasia triloba* Turcz. A – leaves and inflorescence; B – typical trilobed mature leaves and stipules; C – flower showing three epicalyx bracts subtending the petaloid calyx, both of which have very few multiangulate stellate hairs; D – detail of an anther, glabrous style and ovary with an indumentum of stellate hairs with short arms. Scale bars = 10 mm (A); 2 mm (C); 1 mm (D). Voucher: *J. Drummond* 106 (NSW386401). Illustration by Lorraine Cobb.

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With so many species of *Thomasia* being poorly known it is hoped that a key to the genus will prove useful. As noted in a recent key of the closely related genus *Lasiopetalum* Sm. (Shepherd & Wilkins 2018), the size, shape, dissection, and indumentum of juvenile leaves can vary considerably as plants mature. Similarly, the petaloid calyx in *Thomasia* can also expand during development. As such, characters in the key are based on observations of herbarium specimens and field collections of fully developed leaves from mature plants with flowers at anthesis. The form and shape of hairs can be diagnostic and stellate hairs may be multiangulate (Figure 2C) or flat and scale-like with fused arms (Figure 2B). Anthers may exhibit poricidal (Figure 2D, F; Figure 3E) or early lateral dehiscence as seen in *T. foliosa* J.Gay and allied taxa (Figure 2E), and the true petals, if present, are small and scale-like (Figure 3C, F), and may be glabrous (Figure 2D) or covered in stellate hairs (Figure 2F). The indumentum of the ovary may also be important and comprise white multiangulate stellate hairs (Figure 2D, F), pink stellate hairs with very short arms (Figure 3B) or flat, scale-like hairs (Figure 2E). Alternatively, the ovary may have an indumentum that is a mixture of stellate hairs and stalked glandular hairs (see Figure 1F, Shepherd & Wilkins 2018 for glandular hairs) or is papillate and covered in multicellular, sessile (or almost so), wart-like bumps (Figure 2G).

Key to species of *Thomasia*

*taxa appear in more than one section of key

1. Stipules absent; flowering stems mainly with only scale-like stellate hairs or a mix of scale-like and scattered multiangulate stellate hairs

2. Leaves narrowly ovate to oblong-linear, usually >15 mm long

3. Calyx inner surface stellate hairy (NE Northcliffe–Fitzgerald River NP) .... **T. stelligera**

3: Calyx inner surface glabrous (New Norcia)... **T.** sp. **GreenHill***

2: Leaves ovate, oblong to orbicular, < 15 mm long

4. Style 5-winged; petals absent; ovary with peltate scale-like stellate hairs over glandular hairs (Albany E–Esperance W) .... **T. pygmaea**

4: Style filiform; petals present; ovary with peltate scale-like stellate hairs or flat stellate hairs

5. Ovary with 4–5 locules; petals with dense marginal peltate scale-like stellate hairs or multiangulate stellate hairs; calyx > 8 mm long; peduncles < 6 mm long (Mount Holland) .... **T. gardneri**†

5: Ovary with 3 locules; petals glabrous or occasional scale-like stellate hairs on abaxial surface; calyx < 8 mm long; peduncles > 7 mm long

6. Leaves usually > 7 mm long, lower leaf surface with flat scale-like stellate hairs, sometimes with occasional multiangulate stellate hairs; peduncles (10–)30–50 mm long with 3–7 flowers

7. Calyx outer surface with flat scale-like stellate hairs alone, inner surface glabrous; leaves with midvein only indented (New Norcia) .... **T.** sp. **GreenHill***

7: Calyx outer surface with flat scale-like and scattered multiangulate stellate hairs, inner surface with scattered white stellate hairs; leaves with midvein and minor veins indented (W of Woodanilling) ....**T.** sp. **Arthur River**

6: Leaves < 7 mm long, lower leaf surface with peltate scale-like stellate hairs; peduncles 10–23(–30) mm long with 1–2(3) flowers (Ongerup–Esperance east)...... **T. microphylla**

1: Stipules present, leaf-like and conspicuous or minute and inconspicuous; flowering stems with only multiangulate stellate hairs

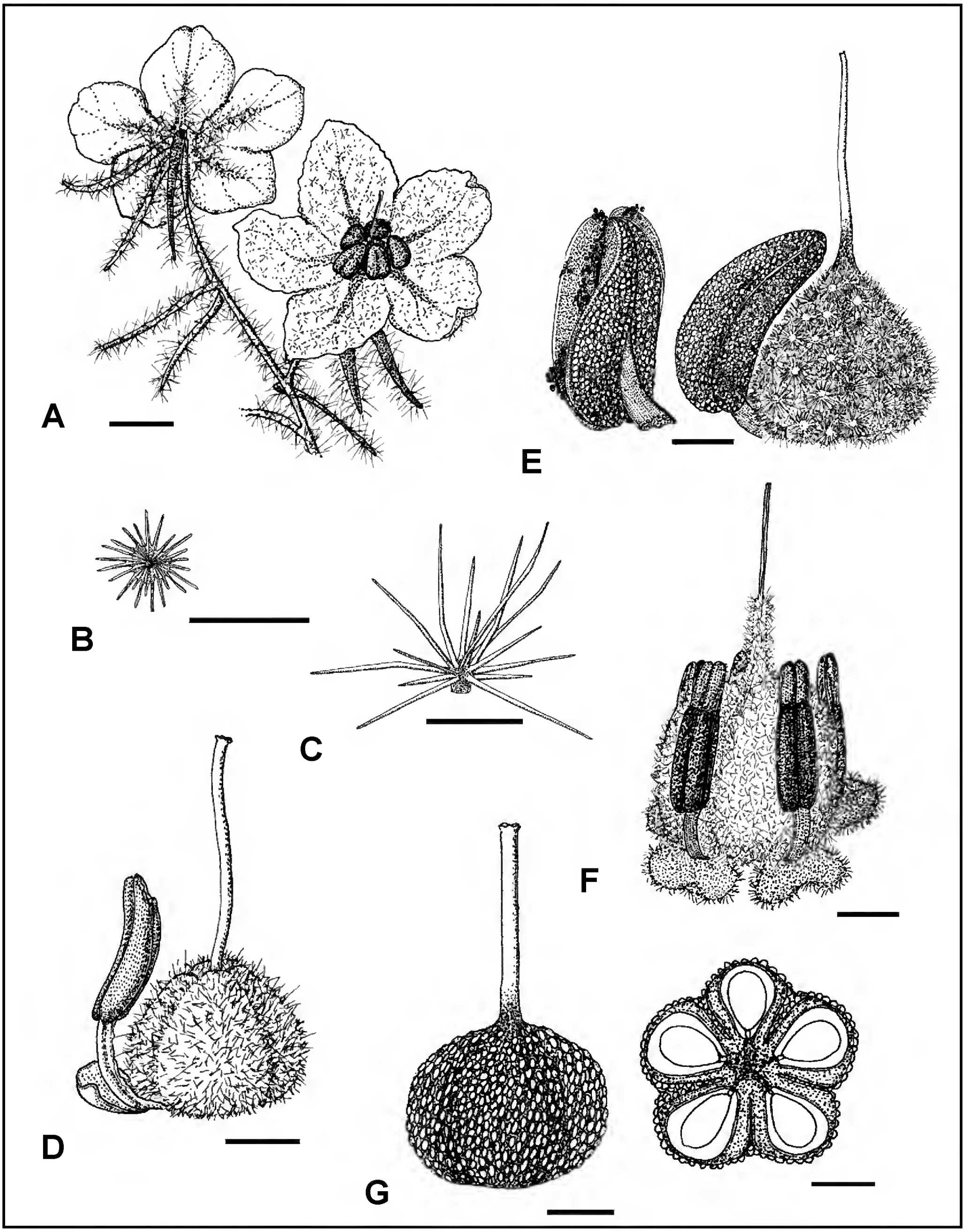

Figure 2. Floral features of *Thomasia*. A – flower showing the petaloid calyx and stellate hairs with long arms on the peduncle and epicalyx bracts; B – flat scale-like hair; C – multiangulate stellate hair; D – anther with poricidal dehiscence, glabrous scale-like petal, ovary with stellate hairs, and a glabrous style; E – anthers with early lateral dehiscence and ovary with flat, scale-like stellate hairs and a glabrous style; F – anthers with poricidal dehiscence, scale-like petals with dense stellate hairs, ovary with stellate hairs, and base of style prominently tomentose to 1/3 of length; G – papillose ovary with a glabrous style, transverse section showing 5 carpels. Scale bars = 2.5 mm (A); 0.25 mm (B); 1 mm (C); 0.5 mm (D); 0.5 mm (E); 1 mm (F); 0.5 mm (G). Vouchers: *Thomasia* sp. Vasse (C. Wilkins & K. Shepherd CW 581) (*K.A. Shepherd & J.A. Wege* KS 345) (A–C, E); *T.* sp. Hopetoun (K.R. Newbey 4896) (*K.A. Shepherd & J.A. Wege* KS 277) (D); *T. paniculata* Lindl. (*P.M. Olde* 678, NSW 270044) (F); *T. rulingioides* Steud. (*K.A. Shepherd & J.A. Wege* KS 201) (G). Illustration by Lorraine Cobb.

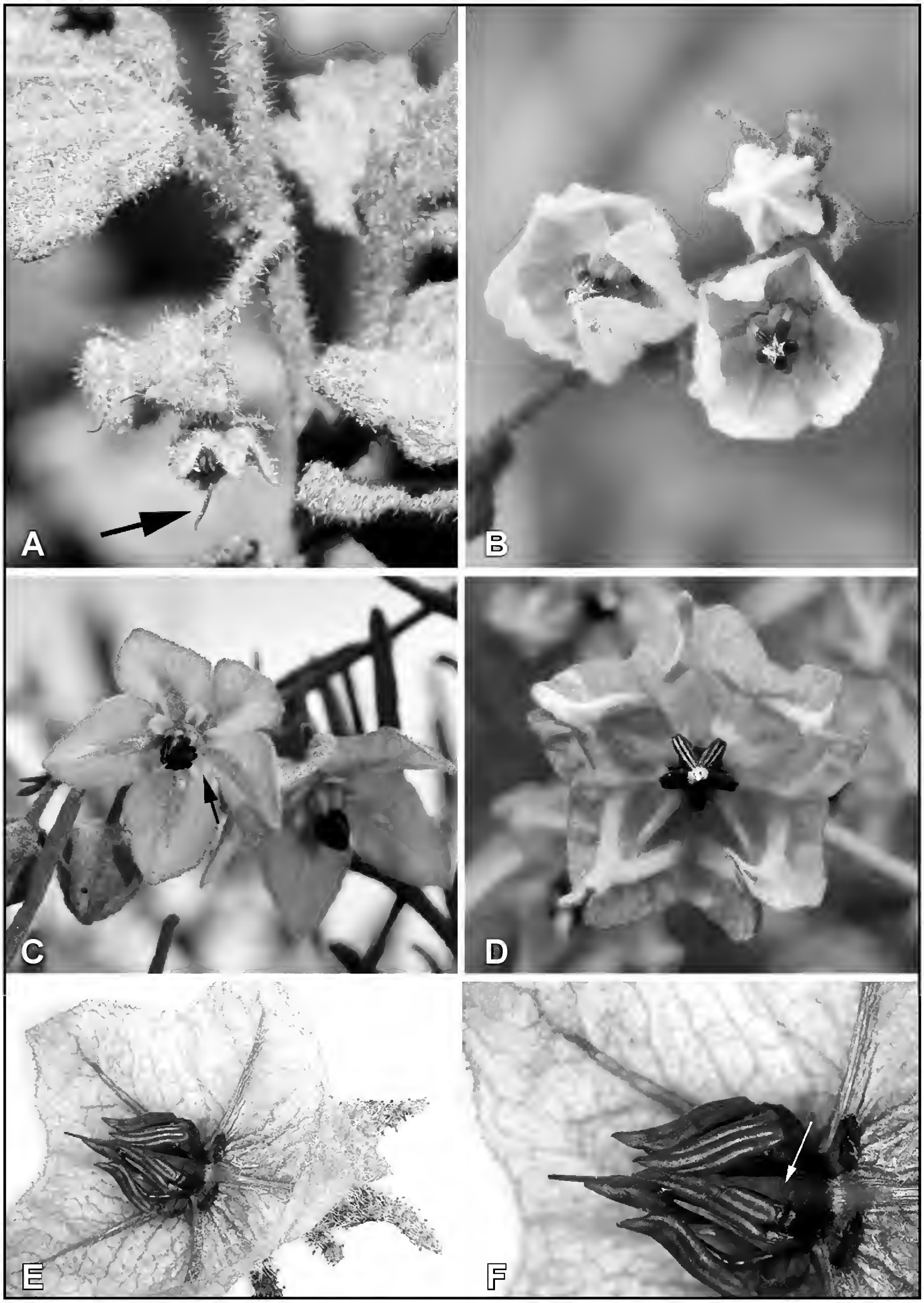

Figure 3. Informative floral characters in *Thomasia*. A – style > 3 times longer than ovary and well exserted from the calyx; B – ovary with pink stellate hairs with short arms to 0.15 mm long; C – scale-like petals (black arrow); D – calyx thickened along the central area with thin, undulating margins; E – poricidally dehiscent anthers; F – perigynous cup with staminodes (white arrow). Vouchers: *T. aff. foliosa* (*K.A. Shepherd & C.F. Wilkins* KS 1614) (A); *T. pauciflora* Lindl. (*K.A. Shepherd & C.F. Wilkins* KS 1643) (B); *Thomasia sarotes* Turcz. (*K.A. Shepherd et al.* KS 1462) (C); *T. grandiflora* Lindl. (in cultivation) (D); *T. montana* Steud. (*D. Rasmussen* 2013/003) (E, F). Images by K.A. Shepherd.

8. Stipules conspicuous; anthers poricidally dehiscent or with late lateral splitting; style *c.* 2 times longer than ovary and not well exserted from the calyx

9. Leaves and stipules linear, with margins tightly revolute

10. Inflorescence with 2 flowers (rarely 3); calyx < 4.5 mm long; ovules 2 per locule (Hopetoun–Ravensthorpe)........ **T.** sp. **Hopetoun**

10: Inflorescence with 3–6 flowers; calyx usually > 4.5 mm long; ovules 6–8 per locule (Mukinbudin–Quaalup)........ **T. sarotes**

9: Leaves and stipules not linear, margins flat or scarcely recurved to recurved

11. Mature leaves lobed

12. Mature leaves divided almost to midvein, appearing 'oak-like'

13. Leaves coriaceous, lower surface with a close tomentum of short stellate hairs each with arms to 0.2 mm long (Denmark–Esperance)........ **T. quercifolia**

13: Leaves soft, lower surface with scattered to medium dense long stellate hairs each with arms to 0.8 mm long (Augusta–Denmark)........ **T.** sp. **Vasse**

12: Mature leaves lobed or trilobed, not divided almost to the midvein

14. Leaves discolorous, lower surface with a close tomentum of stellate hairs; calyx 13–20 mm long with a strongly dissected tube *c.* 20% of the total length (Albany)........ **T. discolor**

14: Leaves almost concolorous, lower surface with scattered to dense stellate hairs; calyx 6–10 mm long with a moderately dissected tube *c.* 40% of the total length

15. Leaves (20)30–83 mm long, soft, lower surface with moderately dense stellate hairs

16. Petals absent or minute *c.* 0.4 mm long; epicalyx bracts narrowly obovate or narrowly elliptic (Denmark–Bremer Bay)........ **T. solanacea**

16: Petals > 1 mm long; epicalyx bracts ovate (Stirling Range National Park)........ **T. brachystachys**

15: Leaves 12–44 mm long, coriaceous, lower surface glabrous or with scattered stellate hairs

17. Leaf margins strongly multi-lobed with a ±trilobed base, lamina usually longer than wide; anther filaments > 2.5 mm long (Cervantes to Esperance in coastal heath)........ **T. triphylla**

17: Leaf margins distinctly trilobed, lamina as long as wide; anther filaments < 2 mm long (Unknown)........ **T. triloba**

11: Mature leaves entire to scarcely sinuate, not distinctly lobed

18. Stamens and staminodes united in a glabrous or hairy perigynous cup *c.* 2 mm long (often longer than the ovary)

19. Perigynous cup hairy (Perth–Bridgetown)........ **T. macrocarpa**

19: Perigynous cup glabrous

20. Petals with scattered to dense stellate hairs (Brookton–Tutanning NR)........ **T. montana**

20: Petals glabrous (York area)........ **T. glabripetala**

18: Stamens free or scarcely united at base, or with a glabrous staminal tube < 0.8 mm long

21. Calyx thickened along the central area either side of the midvein and with thin, undulating margins; leaves usually coriaceous with very few scattered

stellate hairs (Geraldton-Augusta-Esperance) .... **T. grandiflora**

21: Calyx thin except for midvein; leaves thin and soft, indumentum various

22. Leaves usually discolorous with a tomentose indumentum of dense stellate hairs below (Dryandra–Stirling Range NP) ....**T. dielsii**

22: Leaves almost concolorous with an indumentum of scattered to moderately dense stellate hairs below

23. Leaves < 10 mm long; pedicels with long glandular hairs (Morawa–Bencubbin)..**T. tremandroides**

23: Leaves > 10 mm long; pedicel with glandular hairs absent or inconspicuous

24. Ovary with ±sessile papillose glands sometimes mixed with stellate hairs, without stalked glandular hairs

25. Petioles 0.2–1.5 mm long; leaf margins strongly recurved; upper surface of epicalyx bracts glabrous or rarely with 1–2 hairs (S of Dongara–N of Cervantes) .... **T. rulingioides**

25: Petioles (1.6–)2–8 mm long; leaf margins scarcely recurved; upper surface of epicalyx bracts with hairs throughout

26. Calyx usually < 6.5 mm long, ovules 2 per locule

27. Ovary with red papillose glands only; flowers (3–)5–6 per inflorescence (Albany area)... **T. purpurea**

27: Ovary with red papillose glands and scattered to dense white stellate hairs at the apex; flowers (4)5–8(–12) per inflorescence (Albany).. **T. multiflora**§

26: Calyx usually > 6.5 mm long; ovules 4–8 per locule

28. Calyx lobes broadly ovate, *c.* 6 mm wide, tube almost half of total length; ovary with papillose glands only (Three Springs–Israelite Bay) ... **T. macrocalyx**

28: Calyx lobes ovate to narrowly ovate, *c.* 3.5 mm wide, tube < 20 % of total length; ovary with papillose glands only or a mix of papillose glands and white stellate hairs (Frankland River–W of Cape Arid NP; SA, Vic) .... **T. petalocalyx**

24: Ovary with stellate hairs, sometimes with white, red- or pink-tipped stalked glandular hairs, or with stalked glandular hairs only

29. Base of style prominently tomentose to 1/3 of length; leaf margin recurved but entire to scarcely crenulate

30. Ovary with short stellate hairs only

31. Epicalyx bracts ovate, (1.7–)2–3 mm wide; flowers 1–2(3) per inflorescence; ovules (2–)4–7 per locule ; erect spreading shrub (Gracetown–Albany–Stirling Range National Park)..............................**T. rhynchocarpa**

31: Epicalyx bracts narrowly ovate, 0.8–1 mm wide; flowers (2)3(4) per inflorescence; ovules 2 per locule; low mounded shrub (Perth–Augusta–E of Albany) .... **T. pauciflora**

30: Ovary with short stellate hairs and conspicuous glandular hairs 0.5–0.6 mm long

32. Inflorescence a monochasium of < 3–7(–9) flowers; calyx > 7 mm long; leaves usually narrowly ovate (L:W *c.* 6:1) (Perth–Albany) .... **T. paniculata**

32: Inflorescence a dichasium or monochasium of 7–20 flowers; calyx < 7 mm long; leaves usually ovate (L:W *c.* 2.5:1) (N of Collie–W of Pemberton–E to the Porongurups) .... **T.** sp. **Big Brook**

29: Base of style completely glabrous or with a few stellate hairs; leaf margin recurved and somewhat crisped

33. Leaves ovate, 8–27 mm wide

34. Leaf upper surface prominently rugose; epicalyx bracts 2.1–3.3 mm wide; petals absent (Wongan Hills–E of Ravensthorpe) .... **T. rugosa**

34: Leaf upper surface not prominently rugose; epicalyx bracts 0.8–1.2 mm wide; petals stellate hairy (Carnamah to Bendering) .... **T. tenuivestita**

33: Leaves narrowly ovate, elliptic or oblong, 1.2–8 mm wide

35. Petals with stellate hairs on the margin; anthers <1.5 mm long; ovary hairs 0.7–1.25 mm long; peduncle stellate hairs with arms to 1.3 mm long (Cervantes–Esperance, in coastal heath) .... **T. cognata**

35: Petals glabrous; anthers > 1.7 mm long; ovary hairs 0.15–0.3 mm long; peduncle stellate hairs with arms 0.2–0.4 mm long

36. Leaves with veins scarcely impressed; inflorescence < 60 mm long; epicalyx bracts *c.* 1.5 mm wide; flowers 5-merous; anthers 1.8–1.9 mm long; ovules 2 per locule (Kojonup–Israelite Bay)............ **T. angustifolia**

36: Leaves with veins strongly impressed; inflorescence > 60 mm long; epicalyx bracts 2.1–4 mm wide; flowers 5- or 6-merous; anthers *c.* 3 mm long; ovules 6–8 per locule (Three Springs)................................. **T. formosa**[#]

8: Stipules minute and inconspicuous; anthers showing early lateral dehiscence; style > 3 times longer than ovary and well exserted from the calyx[∞]

37. Leaf lower surface and calyx outer surface with a dense indumentum of small stellate hairs, each with *c.* 12 arms (*c.* 0.2 mm long) arms, beneath moderately dense large stellate hairs (*c.* 0.5 mm long); moderately dense red-tipped glandular hairs on new growth and outer calyx of flowers in bud (Lesueur NP) .... **T.** sp. **Lesueur**

37: Leaf lower surface and base of calyx outer surface with an indumentum of very few small stellate hairs, each with *c.* 6 arms (0.2 mm long), beneath moderately dense large stellate hairs (0.5 mm long); scattered red-tipped glandular hairs on new growth and outer calyx of flowers in bud (Eneabba–Esperance E).................................. **T. foliosa**

[†]Presumed extinct (see Smith & Jones 2019).

[§]*Thomasia multiflora* is currently only known from two collections (*L. Diels* 5528, *K. Newbey* 4869). This species is poorly differentiated from *T. purpurea* and may not be supported as distinct.

[#]Possible hybrid between *Lysiosepalum rugosum* × *T. macrocalyx* (see Wilkins & Chappill 2001: 593).

[∞]Further work is required to resolve this complex. *Thomasia foliosa* and *T.* sp. Lesueur (M. Hislop 4217) usually have dark green leaves with an indumentum of scattered stellate hairs on the upper leaf surface; however, a variant currently determined as *T. aff. foliosa* (*K.A. Shepherd & C.F. Wilkins* KS 1614, *K.A. Shepherd & C.F. Wilkins* KS 1617) with pale green leaves and an indumentum of dense stellate hairs on the upper leaf surface (Figure 3A) was collected east of Bindoon, co-occurring with typical *T. foliosa* (*K.A. Shepherd & C.F. Wilkins* KS 1616, *K.A. Shepherd & C.F. Wilkins* KS 1616b). Furthermore, another unusual specimen (*C.W. Parker* 1628.08) with affinity to the closely allied *T.* sp. Lesueur (M. Hislop 4217) was collected east of Hopetoun, which is more than 800 kms to the south of known populations.

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We sincerely thank Wendy Thompson for her helpful review, John Huisman for editorial assistance, and our late friend Lorraine Cobb for her wonderful illustrations. CFW was partially funded by a Science Project Support Grant from Biodiversity and Conservation Science (DBCA). The Australian Biological Resources Study is also gratefully acknowledged for financing early aspects of this research including the illustrations.

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Two new Western Australian species segregated from *Banksia densa* (Proteaceae)

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Abstract

Thiele, K.R. Two new Western Australian species segregated from *Banksia densa* (Proteaceae). *Nuytsia* 30: 203–214 (2019). *Banksia densa* A.R.Mast & K.R.Thiele has until now been regarded as a widespread species in the Western Australian wheatbelt, comprising a widespread nominate variety and a geographically more restricted variety in the southern part of its range (var. *parva* (A.S.George) A.R.Mast & K.R.Thiele). An informally recognised morphological variant, which matches the type of the species, is geographically restricted to an area on the edge of the species range in the immediate vicinity of Corrigin. Morphological assessment shows that the Corrigin form differs significantly in leaf morphology from the remainder of the species and comprises the true *B. densa*. The widespread taxon previously referred to as *B. densa* var. *densa*, and the southern var. *parva*, are here raised to species rank as *B. zygocephala* K.R.Thiele *sp. nov.* and *B. parva* (A.S.George) K.R.Thiele *comb. et stat. nov.* respectively.

Introduction

Banksia densa A.R.Mast & K.R.Thiele was described, as *Dryandra conferta* Benth., by Bentham (1870) based on a specimen collected by James Drummond from south-west Western Australia and distributed in his third collection as n. 295. Drummond's third collection comprised specimens collected between Toodyay and Albany, and in the vicinity of Bolgart (Erickson 1969; George 2009).

All species of *Dryandra* R.Br. were transferred to *Banksia* by Mast and Thiele (2007). The replacement name *B. densa* was used for *D. conferta* due to the preoccupation of the original epithet in *Banksia* by the eastern Australian *B. conferta* A.S.George.

George (1996) placed *B. densa* (as *D. conferta*) in *Dryandra* ser. *Obvallatae* Benth., which he recircumscribed to include five (later seven; see George 1999) species: *B. fasciculata* (A.S.George) A.R.Mast & K.R.Thiele, *B. densa*, *B. columnaris* (A.S.George) A.R.Mast & K.R.Thiele, *B. platycarpa* (A.S.George) A.R.Mast & K.R.Thiele, *B. seneciifolia* (R.Br.) A.R.Mast & K.R.Thiele, *B. rufistylis* (A.S.George) A.R.Mast & K.R.Thiele and *B. insulanemorecincta* (A.S.George) A.R.Mast & K.R.Thiele. All these have an unusual inflorescence morphology in *Banksia*, with the flowers all

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'downcurved' (George, 1996) giving the inflorescences a distinctive zygomorphic, bilateral symmetry (inflorescences in most other species in the genus are radially symmetric).

Six of the seven species of ser. *Obvallatae* were included in a molecular phylogeny of *Banksia* by Cardillo and Pratt (2013). Five of these (*B. fasciculata*, *B. densa*, *B. platycarpa*, *B. rufistylis* and *B. insulanemorecincta*) form a clade, albeit with weak support. Sister to this clade is *B. pallida* (A.S.George) A.R.Mast & K.R.Thiele, which George (1999) placed in *D.* ser. *Armatae* Benth. The sixth included species in ser. *Obvallatae*, *B. columnaris*, was resolved close to but separate from the clade comprising the other ser. *Obvallatae* species. Support values on nodes in the dryandra clade on the Cardillo and Pratt (2013) phylogeny are extremely low, substantially reducing confidence that the clades recovered there are meaningful. However, the fact that most of the included ser. *Obvallatae* species were recovered as a clade indicates that the series is probably monophyletic or largely so. *Banksia pallida*, the species placed sister to the ser. *Obvallatae* species by Cardillo and Pratt (2013), also has a zygomorphic, bilaterally symmetric inflorescence with down-curved flowers, indicating that it may be misplaced in George's ser. *Armatae* (all other species in that series have radially symmetric inflorescences) and that this feature may be a synapomorphy for the clade. Only six other species in the dryandra clade (the species in George's ser. *Concinnae* Benth. and *Plumosae* A.S.George) have zygomorphic inflorescences, but in these cases the styles curve upwards whereas in ser. *Obvallatae* and *B. pallida* they curve downwards.

George (1996) segregated plants from the southern part of the range of *D. conferta*, having smaller flowers and velvety rather than villous involucral bracts, as *D. conferta* var. *parva* A.S.George. Even with var. *parva* excluded, he commented (George 1996: 387) that var. *conferta* (i.e. *B. densa* var. *densa*) was a variable taxon, noting that 'typical var. *conferta* has linear leaf teeth and is of spreading habit' while 'the more common form has broad teeth and is columnar'. Despite this comment, he circumscribed var. *conferta* to include both these forms.

Cavanagh and Pieroni (2006) recognised George's 'typical' morphotype (that is, the form with linear leaf teeth that includes the type of *D. conferta*) as a 'Corrigin form', distinct from the widespread form which they called *D. conferta* var. *conferta*. They noted that the 'Corrigin form' is restricted to a small area of roadside between Corrigin and Quairading and has bluish leaves in the field.

Mast and Thiele (2007), when transferring all species of *Dryandra* to *Banksia*, provided the new combinations *Banksia densa* var. *densa* and *B. densa* var. *parva*, without an assessment of the status of these two taxa or of the variability described by George (1996) and Cavanagh and Pieroni (2006).

The present study was instigated when Margaret Pieroni brought to my attention the vulnerable state of the only population known to her of the 'Corrigin form'. Weed invasion at the site and roadside clearing had reduced this population to a small number of individuals, raising the possibility, if the 'Corrigin form' and the more widespread morphotype discussed by George (1996) are distinct taxa, that urgent conservation assessments and action may be needed for the former.

An initial assessment of all specimens of *B. densa* held at PERTH showed that the two morphotypes included under var. *densa* are in fact readily separable on the basis of leaf morphology. Given this, and to trigger a desktop assessment of conservation status of the 'Corrigin form', the phrase name *Banksia densa* var. Wheatbelt (M. Pieroni s.n. PERTH 04083407) was raised at PERTH for the widespread morphotype. With this change, *B. densa* var. *densa* includes only specimens of the 'Corrigin form'; this was given a conservation ranking of Priority Two on the Western Australian

Department of Biodiversity, Conservation and Attractions' *Threatened and Priority Flora list* (Smith & Jones 2018). Using an informal varietal name for 'var. Wheatbelt' was preferred at that time, pending assessment of appropriate rank.

This paper provides a morphological assessment and taxonomic reappraisal of all three taxa currently recognised within *Banksia densa*, following a more complete study of specimens held at PERTH and detailed observations in the field.

Materials and Methods

All specimens at PERTH were assessed, both to determine the distinction between *B. densa* var. *densa* and the widespread *B. densa* var. Wheatbelt, and to assess the most appropriate status for these and for *B. densa* var. *parva*. Measurements were made of style length for all specimens with mature flowers, as this feature was used by George (1996) to segregate var. *parva* from var. *densa sens. lat.* (style length 16–26 mm in var. *parva cf.* 25–30 mm in var. *densa*). Given that var. Wheatbelt and var. *parva* are latitudinally separated (with the latter at the southern end of the range of the former), style lengths were plotted against latitude and a regression analysis performed in Genstat v. 19 (VSN International 2017) to assess whether the variation in style length between the two taxa is clinal. All putative taxa were visited and compared in the field during spring 2017. Type specimens were viewed using JSTOR *Global Plants* (https://plants.jstor.org/). Maps are based on all specimens held at PERTH and are drawn using IBRA v. 7 (Department of the Environment 2013) bioregion and subregion boundaries.

Results

Both in the herbarium and in the field, *B. densa* var. *densa* and *B. densa* var. Wheatbelt are clearly separable on the basis of leaf morphology alone (Figure 1). As first noted by George (1996), leaf lobes of *B. densa* var. *densa* are ±linear (parallel-sided) to narrowly triangular, while those of var. Wheatbelt are broadly triangular. While these differences in shape do not lend themselves to simple measurements, in practice all available specimens can be adequately and unambiguously assigned to the two taxa. *Banksia densa* var. Wheatbelt and var. *parva* are distributed more or less along a north-south axis in the Western Australian wheatbelt (Figure 2), with both taxa narrowly sympatric in the southern part of the range of the former, approximately between Nyabing and Ongerup. A plot of style length against latitude (Figure 2) shows that (1) the two taxa have non-overlapping style lengths, and (2) style length in var. Wheatbelt is not correlated with latitude (R^2=0.065, p=0.079 n.s.). Neither of these would be expected if var. *parva* and var. Wheatbelt comprised a single, clinal taxon.

The clear morphological separation between *B. densa* var. *densa*, var. Wheatbelt and var. *parva*, lack of intermediates, lack of any indication of a north-south cline in style length in var. Wheatbelt, and partial sympatry of var. Wheatbelt and var. *parva*, all provide morphological evidence that the three taxa comprise independently evolving lineages. Given the lack of intermediates and clear morphological separation, I regard that species rank is appropriate for all three; accordingly, they are treated below as *B. densa*, *B. zygocephala* K.R.Thiele *sp. nov.* and *B. parva* (A.S.George) K.R.Thiele *comb. et stat. nov.*, respectively.

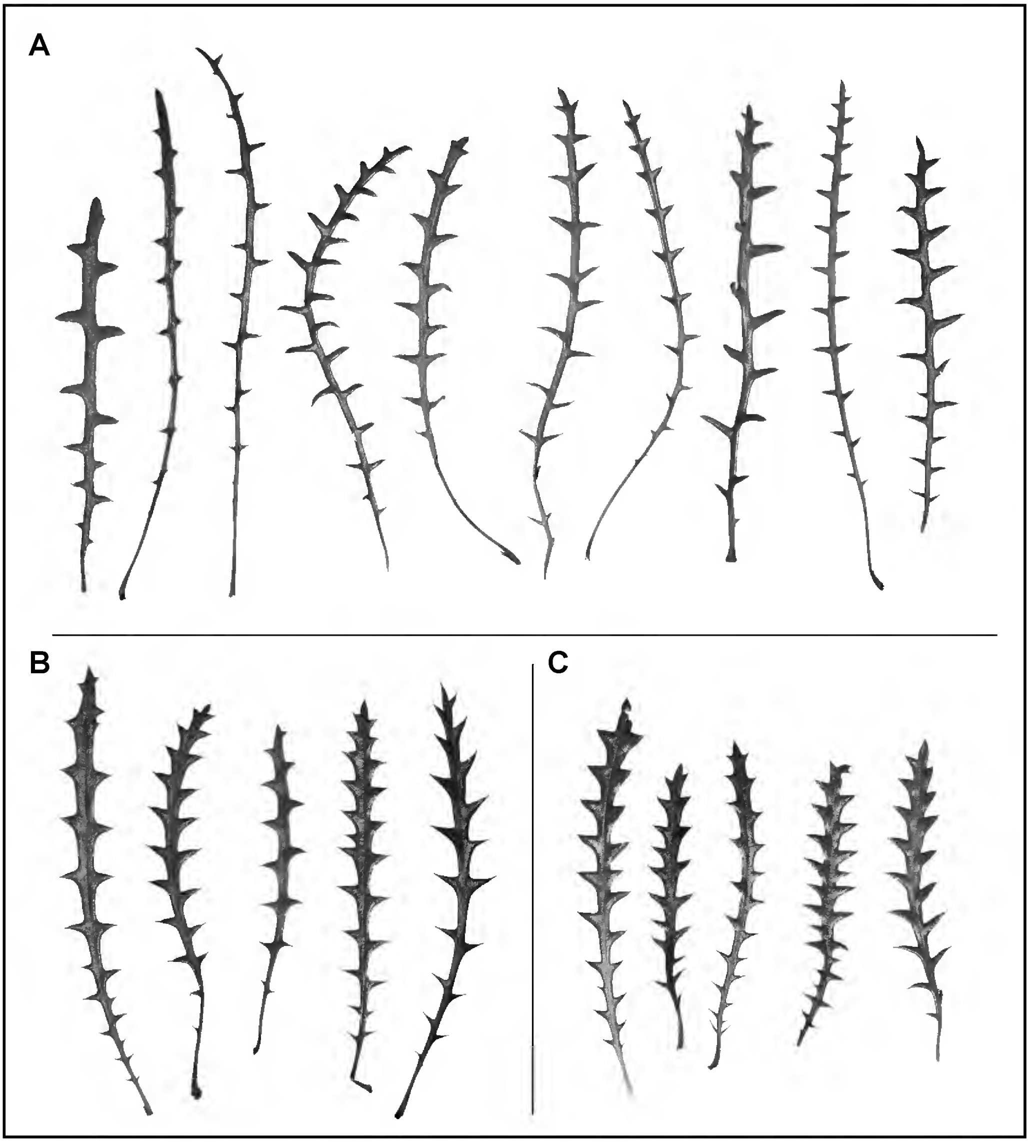

Figure 1. Leaves of the type form of *Banksia densa* (A); the widespread var. Wheatbelt (B); and *B. densa* var. *parva* (C). Top row, from left: *A. Mast* 558; *K.R. Newbey* 2488; *A. Mast* 505; *A.S. George* 16754; *G.S. Durell* 55; *C.A. Gardner* 13621; *K. Alcock* 547; *A. Cochrane* 552; *A.S. George* 14361; *R. Davis* 12819. Bottom row, from left: *R.J. Cranfield* 8066; *G.J. Keighery & N. Gibson* 5801; *R. Meissner* 5654; *G.J. Keighery & N. Gibson* 3470; *A.S. George* 16704; *S. Barrett* 1461; *S. Barrett* 842; *S. Barrett* 1249; *A.S. George* 16691; *A.S. George* 16662.

Key to species previously referred to *Banksia densa*

1. Styles 14–23 mm long .... **B. parva**

1: Styles 26–34 mm long

  2. Leaf lobes broadly triangular, the sides ±straight; plants ±columnar and erect to 3 m ..... **B. zygocephala**

  2: Leaf lobes narrowly triangular to ±linear, the sides nearly parallel before curving to the apex; plants spreading, to 1 m .... **B. densa**

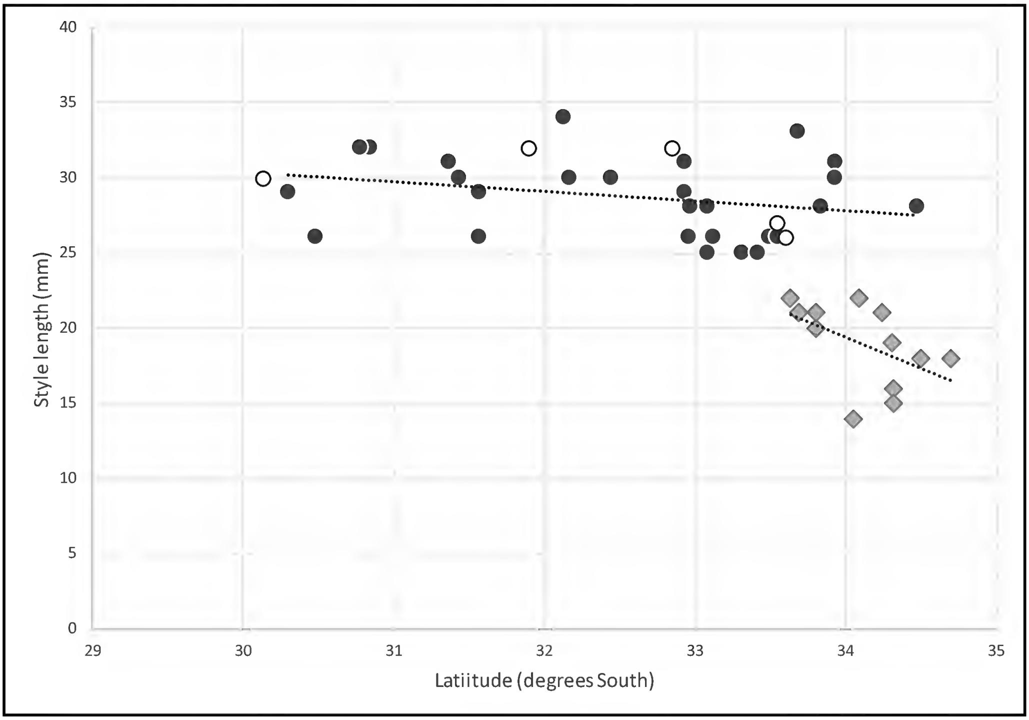

Figure 2. Variation in style length (mm) with latitude for *B. densa* var. Wheatbelt (circles) and *B. densa* var. *parva* (diamonds). Open circles are specimens that were not determined to variety but are within the range of var. Wheatbelt. The regressions (dotted lines) are not significantly correlated with latitude (var. Wheatbelt R^2=0.065, p=0.079 n.s.; var. parva R^2=0.185, p=0.091 n.s.).

Taxonomy

Banksia densa A.R.Mast & K.R.Thiele, *Austral. Syst. Bot.* 20(1): 65 (2007). *Dryandra conferta* Benth., *Fl. Austral.* 5: 578 (1870). *Type citation*: 'W. Australia, Drummond, 3rd. coll. n. 295.' (*lecto*, *fide* George, *Nuytsia* 10(3): 387 (1996): K 796238 image!; *isolecto*: BM *fide* George, *n.v.*, CGE *fide* George, *n.v.*, G 389422 image!, K 796239 image!, K 796237 image!, MEL 602358!, P 750880 image!, PERTH 1590650 [fragments]!).

Non-lignotuberous, rounded to spreading or sprawling *shrubs* to *c.* 1 m high. *Young stems* densely tomentose with short, curled, whitish hairs overtopped by sparse longer, straighter, reddish-brown hairs. *Leaves* pinnatipartite, mostly densely crowded on short-shoots lateral to the main stems, often dull bluish-green, 90–160 mm long, 8–16 mm wide; lamina linear, sparsely to moderately tomentose above with minute, tightly curled, whitish hairs persisting or deciduous above when mature, closely and densely tomentose beneath with pale fawn to whitish, tightly curled hairs obscuring the surface; lobes 6–20 each side, at *c.* 70°–90° to the axis, 3–10 mm long, linear to narrowly triangular, acute, shortly pungent, the margins narrowly revolute. *Inflorescences* lateral on short-shoots; *involucral bracts* very narrowly ovate to linear, acute, the innermost to 17 mm long, sparsely to moderately pale to dark brown-villous with spreading hairs that are denser, darker and less spreading towards the apex. Flowers 56–70 per head, creamy yellow; *perianth* 18–23 mm long, woolly above base, spreading brown-villous above; limb 3–4 mm long, sparsely brown-villous often with an apical tuft of denser hairs. *Pistil* 27–30 mm long, downcurved, glabrous except hirsute immediately above ovary; pollen

presenter 1.5–2.5 mm long, narrowly cylindrical, not distinctly thickened, scarcely contracted to the pistil, faintly ribbed. *Follicles* obliquely obovate, 9–10 mm long, sparsely hirsute.

Diagnostic features. May be distinguished from the other taxa previously included in *B. densa* by the leaf lobes that are narrowly triangular to linear, often bluish-green leaves, and spreading, non-columnar habit.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Aug. 2018, *R. Davis* 12819 (PERTH); 19 Oct. 1961, *C.A. Gardner* 13621 (PERTH); 6 Sep. 1976, *A.S. George* 14361 (PERTH); 2 Aug. 1986, *A.S. George* 16754 (PERTH); 22 Oct. 2004, *A. Mast* 558 (PERTH); 16 Oct. 1966, *K.R. Newbey* 2488 (PERTH).

Phenology. Flowers between April and October with a probable peak in August.

Distribution and habitat. Restricted to an area within a radius of approx. 30 km from Corrigin in the Western Australian wheatbelt (Figure 3). Grows in white to yellow sand over laterite, in open, proteaceous mallee-heath with *Eucalyptus macrocarpa*, *Allocasuarina huegeliana*, *Isopogon divergens*, *Banksia sphaerocarpa*, *B. vestita* and *B. cirsioides*.

Conservation status. Currently listed as Priority Two under the Conservation Codes for Western Australia Flora (Smith & Jones 2018), under the name *Banksia densa* var. *densa*. Historical collections have been made at approx. six localities; however, only two are known to be extant. One 1993 collection (*G.S. Durell* 55) from private land has not yet been revisited.

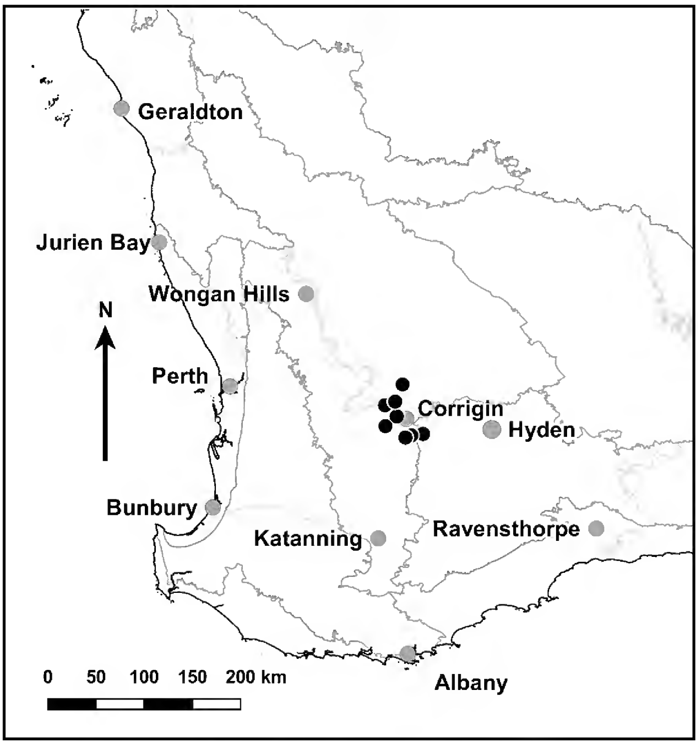

Figure 3. Distribution of *Banksia densa*.

James Drummond is not known to have collected near Corrigin. His 3rd collection comprised specimens collected between Toodyay and Albany, and in the vicinity of Bolgart (Erickson 1969; George 2009). It is possible that *Banksia densa* occurred further west than it does now, before extensive clearing of the wheatbelt.

Notes. *Banksia densa* (formerly *Dryandra conferta*) is here recircumscribed to include only the 'type' or 'Corrigin' form as discussed by George (1996) and Cavanagh and Pieroni (2006), with linear to narrowly triangular leaf lobes and a low, sprawling habit. The foliage of living plants tends to be bluish due to the persistence of an indumentum; however, this is not universal, especially in larger populations.

Banksia zygocephala K.R.Thiele, *sp. nov.*

Type: Nyabing-Kukerin Road, 3.7 km N of Nyabing, Western Australia, 19 August 2018, *K.R. Thiele* 5524 (*holo*: PERTH 09083502; *iso*: CANB, MEL, K).

Banksia densa var. Wheatbelt (M. Pieroni s.n. PERTH 04083407), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 15 March 2018].

Non-lignotuberous, erect, multi-stemmed, usually columnar *shrubs* to 3 m high. *Young stems* densely tomentose with short, curled, fawn to brown hairs overtopped by sparse longer, straighter, reddish-brown hairs. *Leaves* pinnatipartite, mostly densely crowded on short-shoots lateral to the main stems, dull green, 60–160 mm long, 15–20 mm wide; lamina linear, sparsely to moderately tomentose above when young with minute, tightly curled, whitish hairs, glabrous above when mature, closely and densely tomentose beneath with pale fawn to whitish, tightly curled hairs obscuring the surface; lobes 10–18 each side, at *c.* 60°–80° to the axis, 5–10 mm long, broadly triangular, acute, pungent, the margins narrowly revolute. *Inflorescences* lateral on short-shoots; *involucral bracts* very narrowly ovate to linear, sometimes narrowly spathulate at apex, acute, the innermost 15–27 mm long, sparsely to moderately pale- to brown-villous with spreading hairs sometimes restricted to the margins, the hairs denser, darker and less spreading towards the apex. Flowers 55–80 per head, creamy yellow; *perianth* 22–25 mm long, woolly above base, moderately to densely spreading fawn- to brown-villous above; limb 3.5–4 mm long, sparsely brown-villous often with an apical tuft of denser hairs. *Pistil* 26–34 mm long, downcurved, glabrous except hirsute immediately above ovary; pollen presenter *c.* 2 mm long, narrowly cylindrical, not distinctly thickened, scarcely contracted to the pistil, faintly ribbed. *Follicles* obliquely obovate, 9–14 mm long, sparsely to moderately hirsute. (Figure 4.)

Diagnostic features. May be distinguished from the other taxa previously included in *B. densa* by the leaf lobes that are broadly triangular, dull green leaves, usually columnar habit, and pistils 26–34 mm long.

Specimens examined. WESTERN AUSTRALIA: 4 km E of Cadoux, 5 Apr. 1987, *K. Alcock* 548 (PERTH); 26 km due SW of Bodallin, 16 Sep. 1982, *R.J. Cranfield* 2315 (PERTH); Martinjinni Nature Reserve, 18 Sep. 1991, *R.J. Cranfield & P.J. Spencer* 8066 (PERTH); [10 km W of Bodallin on Great Eastern Hwy], 18 Sep. 1962, *A.S. George* 4162 (PERTH); *c.* 22 km SE of Nyabing along Rabbit Proof Fence, 26 Jun. 1976, *A.S. George* 14289 (PERTH); Paterson Rd, 0.7 km W of junction with Balls Rd, NE of Woodanilling, 26 July 1986, *A.S. George* 16633 (PERTH); 26.3 km N of Nyabing on Kukerin Rd, 30 July 1986, *A.S. George* 16704 (PERTH); 4 km E of Cadoux on Johnson Rd, 3 Aug. 1986, *A.S. George* 16762 (PERTH); Kojonup, E side of Merilup Rd, 22 Dec. 1998, *M.S. Graham* 1038 (PERTH); Along E boundary of Harrismith Reserve, 18 Oct. 2001, *K. Kershaw* 2452 (PERTH); 3.9 km

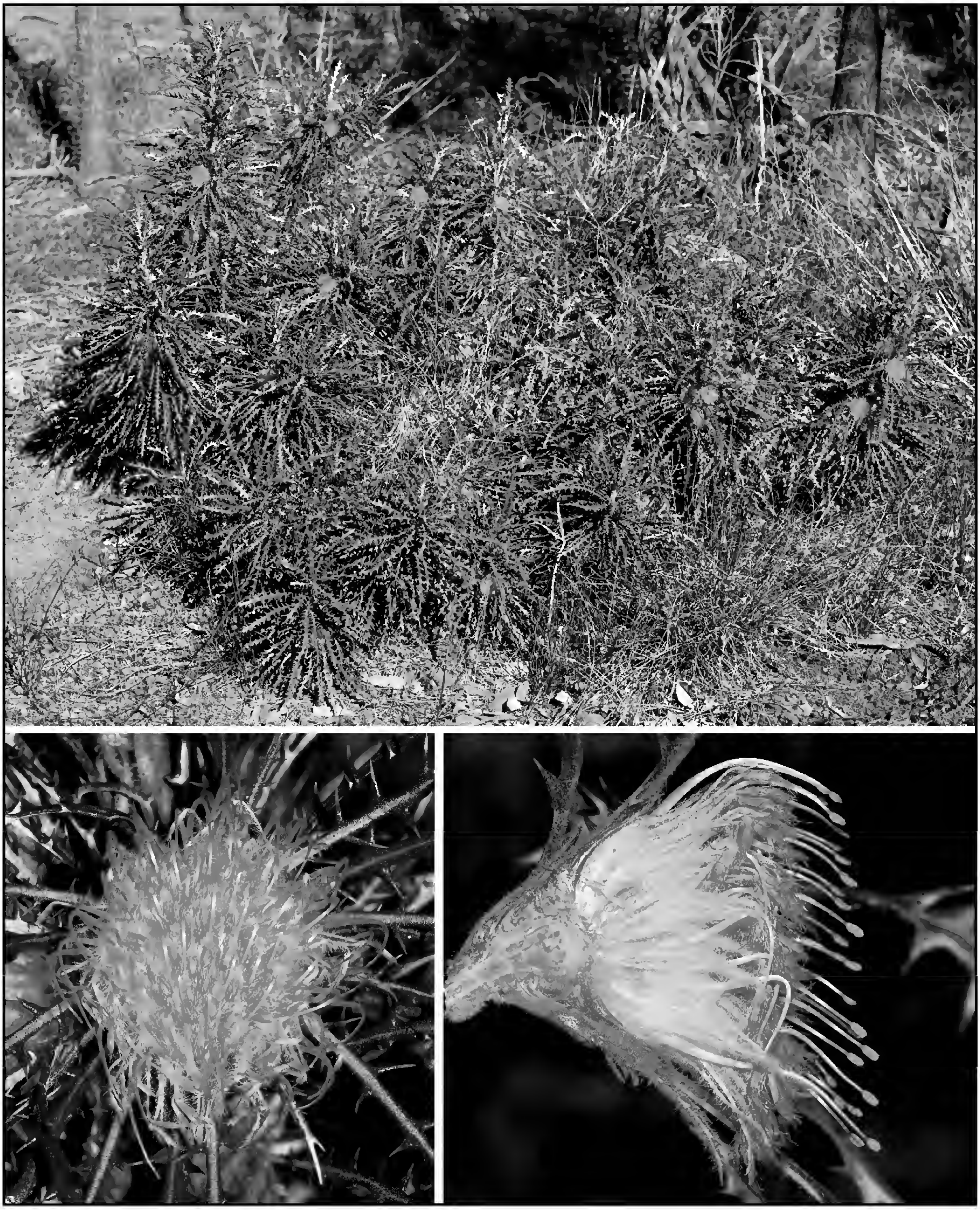

Figure 4. *Banksia zygocephala*: top—habit; bottom left—inflorescence, front view; bottom right—inflorescence longitudinal section, natural orientation. All photos: R. Davis (plants from the type population, Nyabing-Kukerin Rd 3.7 km N of Nyabing, 19 Aug. 2018).

N of Wickepin-Harrismith Rd, *c*. 4 km NE of Harrismith, 28 Aug. 1997, *G.J. Keighery & N. Gibson* 5801 (PERTH); 14.5 km SE of Dumbleyung, 6 Nov. 1992, *S.A. McNee* DY 904 (PERTH); Mount Holland, 14 Oct. 1963, *K.R. Newbey* 1113 (PERTH); Gibb Rock, 1972, *L. Sedgwick s.n.* (PERTH), Miling, Aug. 1972, *Seymour s.n.* (PERTH).

Phenology. Flowers between April and October with a distinct peak in August.

Distribution and habitat. Occurs in two disjunct areas, a northern one between Gunyidi and Lake Cronin and a southern one from around Toolibin to near Ongerup and as far west as Dardadine (Figure 5). An outlying collection from the southern boundary of Stirling Range National Park (*S. Barrett* 843) is well within the range of *B. parva*, but clearly has a style length within the range of *B. zygocephala* and is typical in all respects. In the northern area of distribution, grows in white to yellow clayey sand over laterite, in heathy woodlands with *Eucalyptus oldfieldii*, *E. burracoppinensis*, *E. macrocarpa*, *Acacia yorkrakinensis*, *Banksia armata*, *B. purdieana*, *Beaufortia interstans*, *Melaleuca conothamnoides* and *M. cordata*. In the southern area, grows in white, yellow or brown sands and loams in proteaceous and myrtaceous heath, mallee-heath and open wandoo woodlands with *Eucalyptus pluricaulis*, *Melaleuca platycalyx*, *Allocasuarina thymoides*, *Hakea prostrata*, *H. cygnorum*, *Grevillea cagiana*, *Banksia sphaerocarpa*, *B. baueri*, *B. cynaroides*, *B. nivea*, *B. drummondii* and *Isopogon buxifolius*.

Conservation status. Widespread and not considered to be at risk.

Etymology. From the Greek *zygos* (a yoke, pair) and *kephale* (a head), in reference to the zygomorphic inflorescences with downcurved flowers.

Notes. With the removal of *B. zygocephala* from *B. densa sens. lat.*, a distribution that appeared more or less continuous is now shown to be discontinuous, with a gap of around 125 km between the northern and southern areas of the range of the former. Suitable habitats occur within the gap, indicating that *B. zygocephala* as currently circumscribed may comprise two taxa. Plants from the

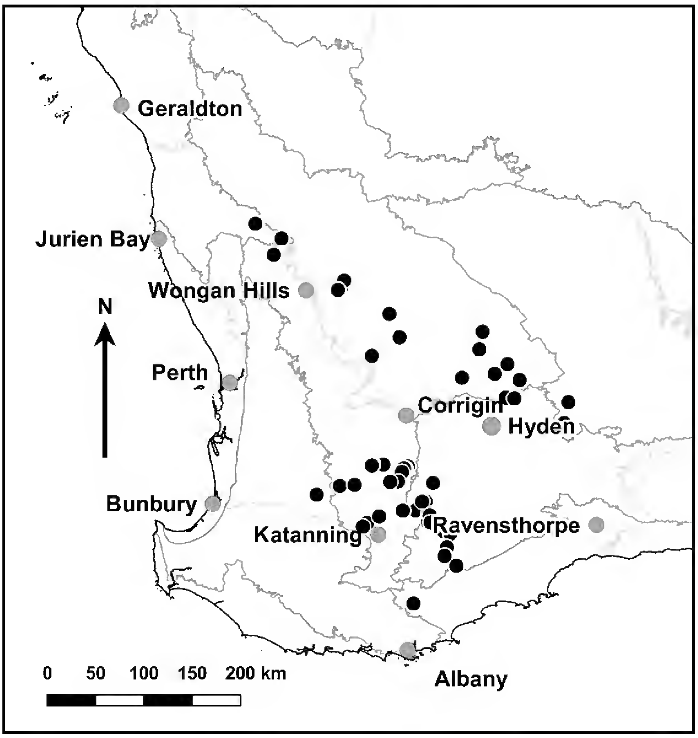

Figure 5. Distribution of *Banksia zygocephala*.

northern area have larger, coarser leaves with more widely spaced and larger leaf lobes than plants in the southern area; however, the differences are subtle and individual specimens are difficult to place. It is currently premature to recognise two taxa, but further work may indicate that this is the case. The type specimen is from the southern area of distribution.

Banksia parva (A.S.George) K.R.Thiele, *comb. et stat. nov.*

Dryandra conferta var. *parva* A.S.George, *Nuytsia* 10(3): 388 (1996). *Banksia densa* var. *parva* (A.S.George) A.R.Mast & K.R.Thiele, *Austral. Syst. Bot.* 20(1): 67 (2007); *Type*: South Fence Rd, 7 km NW of Albany-Lake Grace Rd, SE of Nyabing, Western Australia, 30 July 1986, *A.S. George* 16694 (*holo*: PERTH 03462595!; *iso*: CANB 485326!, PERTH 03462609!).

Non-lignotuberous, erect, multi-stemmed, usually columnar *shrubs* to 1.5 m high. *Young stems* densely tomentose with short, curled, fawn to brown hairs overtopped by sparse longer, straighter, reddish-brown hairs. *Leaves* pinnatipartite, mostly densely crowded on short-shoots lateral to the main stems, dull green, 50–150 mm long, 8–18 mm wide; lamina linear, sparsely to moderately tomentose above when young with minute, tightly curled, whitish hairs, glabrous above when mature, closely and densely tomentose beneath with pale fawn to whitish, tightly curled hairs obscuring the surface; lobes 8–20 each side, at *c.* 60°–80° to the axis, 3–9 mm long, triangular, acute, pungent, the margins narrowly revolute. *Inflorescences* lateral on short-shoots; *involucral bracts* very narrowly ovate to linear, sometimes narrowly spathulate at apex, acute, the innermost to 18 mm long, sparsely to moderately pale- to brown-villous with spreading hairs sometimes restricted to the margins, the hairs denser, darker and less spreading towards the apex. Flowers 40–65 per head, creamy yellow; *perianth* 15–19 mm long, woolly above base, moderately to sparsely to densely spreading fawn- to brown-villous above; limb 3–4 mm long, sparsely to moderately pale brown-villous often with an apical tuft of denser hairs. *Pistil* 14–23 mm long, downcurved, glabrous except hirsute immediately above ovary; pollen presenter *c.* 2 mm long, narrowly cylindrical, not distinctly thickened, scarcely contracted to the pistil, faintly ribbed. *Follicles* obliquely obovate, 6–10 mm long, sparsely to moderately hirsute.

Diagnostic features. May be distinguished from the other taxa previously included in *B. densa* by the leaf lobes that are broadly triangular, dull green leaves, usually columnar habit, and pistils 14–23 mm long.

Specimens examined. WESTERN AUSTRALIA: [precise localities withheld for conservation reasons] North Woogenilup, 3 May 2000, *S. Barrett* 843 (PERTH); Nyabing, 26 June 1976, *A.S. George* 14290 (PERTH); Stirling Range, 27 July 1986, *A.S. George* 16662 (PERTH); Lake Grace, 30 July 1986, *A.S. George* 16691 (PERTH); Porongurup Range, 18 Aug. 1971, *K. Newbey* 3414 (PERTH); Boxwood Hill-Ongerup, 8 July 1987, *M. Pieroni* 33; North Woogenilup, 11 July 1998, *M. Pieroni* 98/3 (PERTH).

Phenology. Flowering specimens have been collected between May and July, with probable peak flowering in the latter month. *Banksia parva* flowers significantly earlier than either *B. densa* or *B. zygocephala*, despite its more southerly range. During field work in mid-August 2018, *B. zygocephala* was in full flower while *B. parva* had consistently finished flowering.

Distribution and habitat. Occurs from Badgebup to the Porongurup Range and east to near Ongerup (Figure 6). Grows in sandy and gravelly loams and sands over laterite, in mallee-heath and shrublands with *Eucalyptus pleurocarpa*, *E. incrassata*, *Allocasuarina huegeliana*, *Hakea varia*, *H. lissocarpha*, *H. marginata*, *Banksia nervosa*, *B. arctotidis*, *B. gardneri*, *B. armata*, *B. sphaerocarpa*, *B. drummondii*,

Regelia inops, and *Xanthorrhoea platyphylla*.

Conservation status. Currently listed as Priority Four under the Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *Banksia densa* var. *parva*.

Notes. *Banksia parva* is morphologically very close to *B. zygocephala*, differing mainly in its shorter styles and perianths. Leaves in *B. parva* also tend to be shorter than in *B. zygocephala*, but the ranges overlap and leaf length and lobe shape is not diagnostic. George (1996) discriminated the two varieties of *B. densa* partly on the indumentum of their involucral bracts, with *B. parva* (as *Dryandra conferta* var. *parva*) described as having velvety bracts and *B. zygocephala* (as *D. conferta* var. *conferta*) having villous bracts. While the indumentum on the bracts of *B. parva* is on average slightly less dense and more spreading than in *B. zygocephala*, the differences are slight, are not consistent, and are difficult to use for diagnosis. Likewise, George (1996) described the follicles of var. *parva* as 'more oblique (almost transversely obovate)' (*l.c.* p. 388). Comparison of a range of follicles of *B. parva* and *B. zygocephala* shows that follicle shape in both species is variable and is not diagnostic.

George (1996) used varietal rank for *Dryandra conferta* var. *parva* based on a ranking scheme used throughout his work at the time. Under this scheme, taxa were given species rank if 'morphological characters and states are considered significant in the context of the genus', subspecies rank was used when 'difference(s) are less significant and there is a geographical and/or ecological discontinuity', and variety was used when 'difference(s) are less significant than at specific rank and there is no geographical or ecological separation' (*l.c.* p. 314).

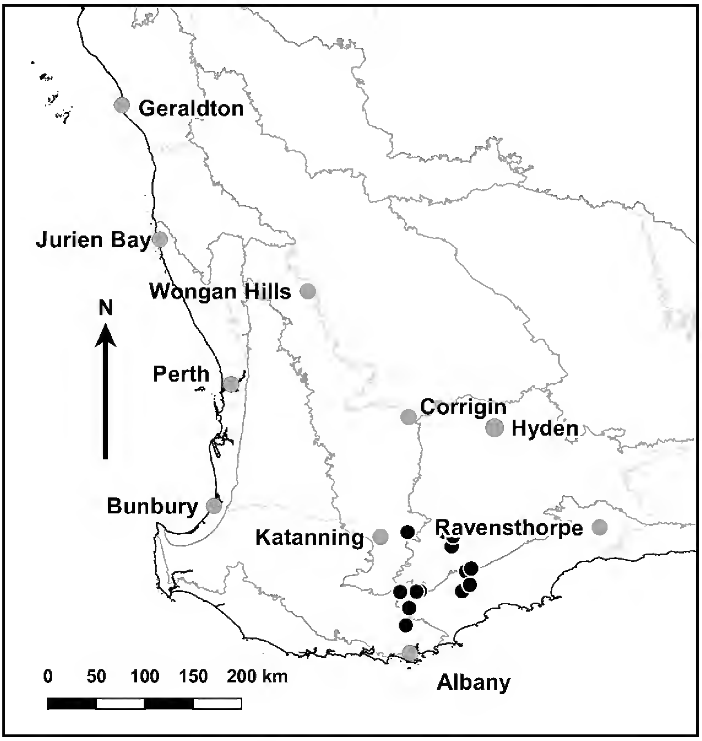

Figure 6. Distribution of *Banksia parva*.

Under this scheme, *D. conferta* var. *parva* was recognised at varietal rank because it comprises southern populations of *D. conferta* that are not ecologically or geographically disjunct from var. *conferta*. I regard, by contrast, that the discontinuity in style lengths between *B. zygocephala* and *B. parva*, despite at least partial sympatry, differences in flowering times, and lack of any indication of clinal variation, indicates that the two taxa are reproductively isolated lineages, and hence are appropriately recognised at species rank.

Summary of taxon circumscriptions

Banksia densa A.R.Mast & K.R.Thiele in this paper has a narrower circumscription than *B. densa* A.R.Mast & K.R.Thiele var. *densa* as previously accepted at PERTH due to the removal of *B. zygocephala*.

Banksia zygocephala K.R.Thiele in this paper is a new taxon and is removed from *B. densa* A.R.Mast & K.R.Thiele var. *densa* as previously accepted at PERTH.

Banksia zygocephala K.R.Thiele in this paper has the same circumscription as *B. densa* A.R.Mast & K.R.Thiele var. Wheatbelt (M. Pieroni s.n. PERTH 04083407) as previously accepted at PERTH.

Banksia parva (A.S.George) K.R.Thiele in this paper has the same circumscription as *B. densa* var. *parva* (A.S.George) A.R.Mast & K.R.Thiele as previously accepted at PERTH.

Acknowledgements

I thank Margaret Pieroni for bringing to my attention the taxonomic and conservation issues around *Banksia densa*, Rob Davis and Tim Hammer for assistance in the field, the Curator and staff of PERTH for access to the collections, and Kelly Shepherd and an anonymous reviewer for helpful comments on the ms.

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30: 215–219 Published online 15 October 2019

Additions to *Eremophila* (Scrophulariaceae)

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Abstract

Chinnock, R.J. Additions to *Eremophila* (Scrophulariaceae). *Nuytsia* 30: 215–219 (2019). One new species of *Eremophila* R.Br., *E. waitii* Chinnock, is described and one subspecies of *E. glabra* (R.Br.) Ostenf., *E.glabra* subsp. *verrucosa* Chinnock, is raised to species level and recognised herein as *E. viridissima* Chinnock.

Introduction

Since the treatment of 215 species of *Eremophila* R.Br. in the Myoporaceae monograph by Chinnock in 2007, an additional 19 species have been added to the genus (See Brown & Buirchell 2007; Chinnock & Doley 2011; Edginton 2015; Buirchell & Brown 2016; Brown & Davis 2016; Brown *et al.* 2018). The addition of the two species here brings the current number of recognised species in *Eremophila* to 238.

A recently discovered endangered species of *Eremophila* from the northern Wheat Belt of Western Australia is described and a subspecies of *Eremophila glabra* (R.Br.) Ostenf., described by Chinnock (2007), is raised here to species level.

Taxonomy

Eremophila waitii Chinnock, *sp. nov.*

Type: Mullewa, Western Australia [precise locality withheld for conservation reasons], 21 September 2018, *R.J. Chinnock* 10600 (*holo*: PERTH 09083618; *iso*: AD, CANB, MEL).

Eremophila sp. Mullewa (R. Wait 7311), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 20 January 2019].

Erect, densely branched aromatic shrub 1–1.5(–2.5) m tall, bark pale grey, rugose. *Branches* distinctly ribbed, ribs extending down from raised leaf bases, obscurely tuberculate, resin extruded in dried specimens as small translucent bubbles, densely finely stellate-tomentose, glabrescent in older parts. *Leaves* very densely clustered along branches, ± alternate-sub-whorled or in whorls of 3, straight or slightly curved, linear-subterete, tapering towards tip, broadly acute to obtuse, (6–)10–18(–26) mm

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× 0.5–0.9(–1.1) mm, dendritic pubescent to dendritic-tomentose, glabrescent. *Flowers* 1 per axil, subsessile (pedicel <1 mm), densely clustered into strobiloid structures 30–40 mm long at branch tips, and flowers developing from base upwards or opening at various positions along strobilus at same time. *Sepals* 5, subequal, valvate, lanceolate, acute, 5–8 × 0.7–1.2 mm; outer surface densely clothed in large dendritic hairs partially or completely obscuring sepals except at tip, inner surface with long dendritic hairs in distal half, glandular pubescent below; green or dark purple. *Corolla* 9–15 mm long, outer surface and inside of lobes and upper inside of tube deep lilac, inside of tube below lower lip white with purple spots; outside surface and inner surface of lobes glabrous, tube with white woolly hairs especially in lower part; lobes obtuse. *Stamens* 4, enclosed, filaments glabrous. *Ovary* oblong, 4-locular with 1 ovule per loculus, glabrous. *Fruit* dry, obconical, 3–4.5 × 2.5–3.0 mm, exocarp papery, bifid at apex, rugulose, very pale brown; endocarp, brown, split into 4 at apex, rugulose, granular with numerous minute resinous spots. *Seed* oblong, *c.* 1.5 × 0.5 mm, pale cream. (Figure 1)

Diagnostic features. *Eremophila waitii* is readily distinguished from other species in *Eremophila* sect. *Australophilae* Chinnock in having sub-whorled to 3-whorled, densely pubescent to densely tomentose, linear-subterete leaves that are clustered along the branches and flowers aggregated together into woolly strobili 30–40 mm long at branch tips.

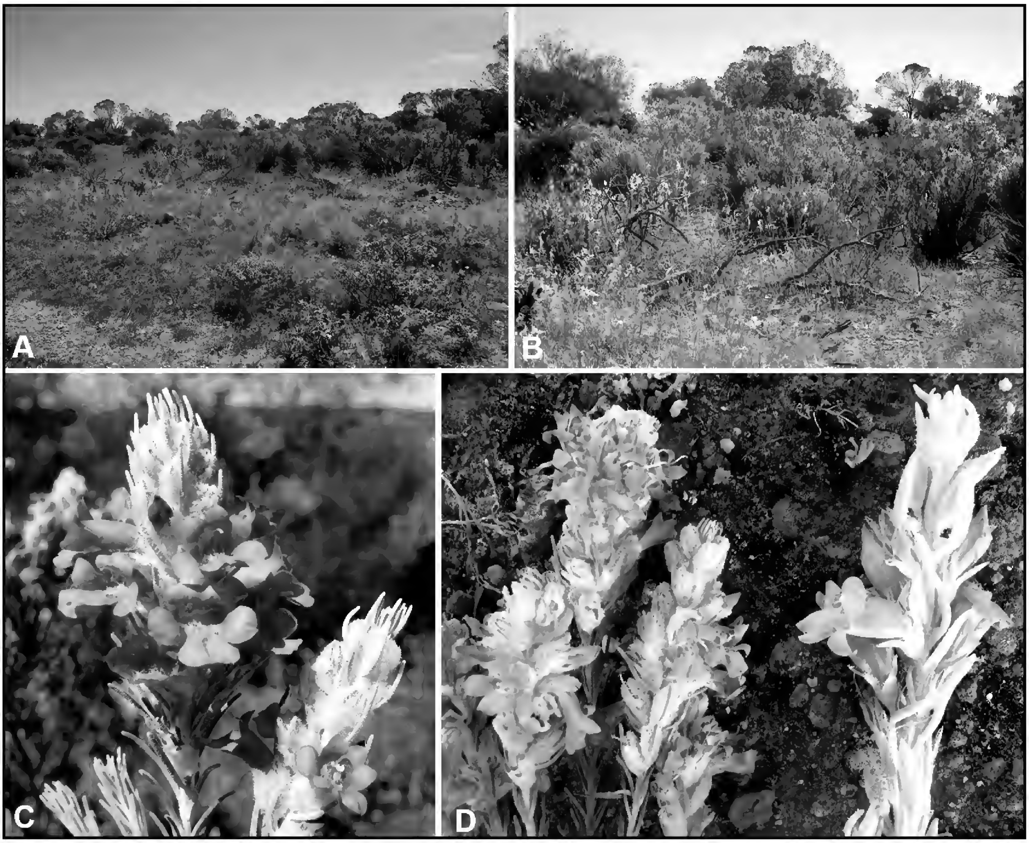

Figure 1. *Eremophila waitii*. A – type population; B – habit, note the much taller senescent plant in background (centre); C – inflorescence showing the well-defined strobili and flowers emerging from various places; D – comparison between *E. waitii* (left) and the larger flowered *E. nivea* (right). Vouchers: *R.J. Chinnock* 10599 (C, D left (right not vouchered). Photographs by R.J. Chinnock.

Other specimens examined. WESTERN AUSTRALIA. [localities withheld for conservation reasons] 14 Sep. 2018, *B. Buirchell* BB332 (PERTH, image seen); 19 Aug. 2018, *R. Wait* 7311 (PERTH, image seen).

Phenology. Flowers appear from late winter to at least mid-spring with fruits maturing from early spring onwards.

Distribution and habitat. *Eremophila waitii* is known only from one population consisting of about 55 plants (Figure 1A) in a very small area around low sandstone rock outcrops. It was growing with *Melaleuca* and *Acacia* species, *Solanum* sp., various chenopods and a mixed annual ground cover of composites and grasses in an open area in remnant low mallee woodland. It is possible that because many of the plants were very close together they may have resulted vegetatively from root-suckering, but this could not be confirmed.

Most plants in the population were between 1–1.5 m tall and wide (Figure 1B) with a rounded crown but a few senescent plants, usually with a few unbranched stems, were up to 2.5 m tall. It was noted that leaves on new vigorous basal branches of actively growing plants are longer (≥18 mm) with a more sparse indumentum and more obviously resinous.

Conservation status. *Eremophila waitii*, is known only from the one population and has recently been listed as a Priority One species under the Conservation Codes for Western Australian flora under the name *Eremophila* sp. Mullewa (R. Wait 7311) (Western Australian Herbarium 1998–).

Etymology. Named after Russell Wait, who over many years has trekked to various parts of Australia, but especially Western Australia, to study and collect *Eremophila*. I am delighted to name this species after him in recognition of the many new or rare species that he has discovered and introduced into cultivation and the significant contribution he has made to our understanding of this genus.

Affinities. *Eremophila waitii* is most closely related to *Eremophila subangustifolia* A.P.Br. & Llorens (see *Notes*) and *E. microtheca* (F.Muell. ex Benth.) F. Muell., sharing with these species the dendritic-pubescent or dendritic-tomentose leaves and branches. It is readily distinguished from these species by having a well-defined strobiloid inflorescences (Figure 3) at the branch tips rather than having scattered flowers along the upper parts of the branches. *Eremophila nivea* Chinnock is also closely related to *E. waitii* sharing a similar dense white to grey-white indumentum on the branches and leaves. *Eremophila nivea* can have a ± loose cluster of flowers near the apex (Figure 4) but it is readily distinguished from *E. waitii* by the larger flowers 15–23 mm long (*cf.* 9–15 mm long), and the distinctly flattened, broader, leaves 1.5–3.5 mm wide (*cf.* 0.5–0.9(–1.1) mm wide).

The four species *E. waitii*, *E. subangustifolia*, *E. microtheca* and *E. nivea* form a well-defined group within *Eremophila* sect. *Australophilae*. All four species share a strong and distinctive musky odour, although it is not initially as strong in *E. waitii* the smell becomes more obvious in dried herbarium specimens.

Notes. Chinnock (2007) noted that northern populations of *E. microtheca* in the Kalbarri National Park differed from more southern ones in the Lake Indoon–Lake Logue depression area, in having distinctly flattened leaves. Brown *et al.* (2018) undertook a molecular study of the two forms and found significant divergences between plants found in the two areas. Subsequent field work and herbarium studies on the populations by one of the authors (A.P. Brown) resulted in additional morphological

features being identified and as a consequence, the southern form was described as a new species, *Eremophila subangustifolia* (Brown *et.al.* 2018).

Eremophila viridissima Chinnock, *nom. et stat. nov.*

Eremophila glabra subsp. *verrucosa* Chinnock, *Eremophila* 592 (2007). *Type*: Lake Raeside, Western Australia, 22 September 1986, *R.J.Chinnock* 7273 (*holo*: AD 98647195; *iso*: K 000961395, MEL 2147389, PERTH 07538677, US 01050399).

Etymology. From the Latin *viridissima*, very green; referring to the deep green leaves.

Figure 2. *Eremophila viridissima* flowering stem showing the distinctive ascending, deep green leaves. Photograph by R.J. Chinnock.

Notes. *Eremophila viridissima* is well defined (see description in Chinnock 2007, p. 592) and is now considered as distinct from typical *E. glabra* as are satellite species like *E. subteretifolia* Chinnock, *E. subfloccosa* Benth. and *E. denticulata* F.Muell. (Figure 2; see also Chinnock 2007, unnumbered Figure on p. 592 and Figure 297 p. 593, as *E. glabra* subsp. *verrucosa*). The species is readily distinguished from *Eremophila glabra* by its ascending, resinous deep green leaves, branches that are usually not divided in the upper parts and its distinctly verrucose endocarp of the fruit. When stressed, leaves of *E. viridissima* may turn yellowish green.

When I published the account of *Eremophila glabra* in 2007, I recognised nine subspecies but noted that the treatment was a tentative subdivision of this large polymorphic super species that includes a number of polyploid states (n=18, 36, 54). A number of these subspecies were known to be complexes in themselves like subsp. *elegans* Chinnock, subsp. *albicans* (Bartling) Chinnock and subsp. *tomentosa* Chinnock. Furthermore, these often showed intergradation e.g. subsp. *elegans* and subsp. *tomentosa.* To further complicate matters, I was also aware that some of the subspecies were essentially 'buckets' consisting of a number of taxa that required a more detailed study before segregation could occur. Subsp. *tomentosa*, for example, consists of at least three taxa: one in inland WA that forms large intricate plants 1.5 m tall and broad; the type form found on coastal cliffs around Kalbarri that is often a spindly shrub up to 1.8 m tall with one or a few main stems branched in the upper parts; and a third common in coastal areas around Geraldton and northwards, including off-shore islands, which is a prostrate plant or an erect shrub. These forms were beyond the scope of the monograph and required a more detailed study to make sense of these complexes. I also acknowledged that *Eremophila glabra* was part of a larger complex, which at that time included seven very closely related species that were actively in the process of speciation. *Eremophila calcicola* R.W.Davis has since been added to this complex (Brown & Davis 2016) and I am also aware of a number of other un-named taxa belonging to this group. Hopefully, the current molecular studies being undertaken by Dr R. Fowler at the University of Melbourne will resolve many of the problems found within the Glabra group.

Acknowledgement

I thank Karina Knight for providing scans of specimens of *Eremophila waitii* held at the Western Australian Herbarium.

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Triodia veniciae (Poaceae), a new species from the Pilbara region, Western Australia

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Abstract

Barrett, M.D. *Triodia veniciae* (Poaceae), a new species from the Pilbara region, Western Australia. *Nuytsia* 30: 221–228 (2019). The Australian hummock grass genus *Triodia* R.Br. is currently undergoing taxonomic revision following increased botanical survey in remote Australia. This paper describes a recently discovered species of 'soft' *Triodia* from the Pilbara region, *T. veniciae* M.D.Barrett. The lemma lobes of the new species are narrow and produced into a short awnlet, intermediate between the old, and now united, generic concepts of *Plectrachne* Henrard with awned lemmas and *Triodia* with lobed lemmas. *Triodia veniciae* M.D.Barrett is only known from rocky shale slopes of the eastern Chichester Range, and has priority conservation status. Diagnostic character combinations for *T. veniciae* are given to allow discrimination from all other *Triodia*.

Introduction

Triodia R.Br. hummock grasses are restricted to mainland Australia, where they are characteristic components of many arid and semi-arid communities, and the dominant elements of hummock grasslands that cover 18% of Australia (Department of the Environment and Heritage 2007). As at late 2018 the genus *Triodia* consists of 82 described and accepted species (Lazarides 1997; Barrett *et al.* 2005; Armstrong 2008; Barrett & Barrett 2011, 2015; Hurry *et al.* 2012; Crisp *et al.* 2015; Anderson *et al.* 2017a; Barrett & Trudgen 2018) but is currently undergoing phylogenetic investigation and taxonomic revision (e.g. Toon *et al.* 2015; Anderson *et al.* 2016, 2017b). This paper describes a new species of *Triodia*, in the group of less pungent species colloquially known as 'soft' spinifex.

In 2016, during a survey of ploidy variation in *Triodia* in the eastern Pilbara, a morphologically anomalous variant was located on shale near Roy Hill Mine, referred to in an unpublished report under the informal name ''*Triodia* sp. Roy Hill (M.D. Barrett MDB 5412)'. Although this taxon had been previously overlooked amongst the similarly resinous *T. epactia* S.W.L.Jacobs, which is abundant in the same area, subtle features of its glumes, lemmas and leaf sheaths were found to be consistently discrete from all known *Triodia* species. Its morphology suggested a relationship with *T.* sp. Karijini (S. van Leeuwen 4111), *T. melvillei* (C.E.Hubb.) Lazarides or *T. basitricha* M.D.Barrett. Despite these

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apparent similarities, DNA sequences from the ITS and ETS regions suggest that it is phylogenetically closer to *T. bynoei* (C.E.Hubb.) Lazarides of the eastern Kimberley and adjacent Northern Territory than to the aforementioned species. Previous reports of *T. bynoei* from the Pilbara region (Lazarides 1997; Lazarides *et al.* 2005) were based on misidentified specimens that are morphologically and genetically indistinguishable from *T. melvillei*. An intensive further survey for the new species located additional populations over a range of *c.* 140 km, between Roy Hill and Mulga Downs, and confirmed its exclusive occurrence on shale substrates. The Roy Hill *Triodia* is described below as a new species, *T. veniciae*.

The lemma lobes of *T. veniciae* could be interpreted as either long lobes or short awns at the extremes of variation, and are here termed 'sub-awned'. Along with *T. hubbardii* and *T. triaristata*, the sub-awned lemma lobes of *T. veniciae* provide an additional example of an intermediate between the old concepts of *Plectrachne* Henrard and *Triodia*, which were delimited on the presence or absence of lemma awns. As noted by Lazarides (1997), lemma lobing is untenable as a generic character, and the presence of an awn is homoplastic across the whole of *Triodia s. lat.* (Toon *et al.* 2015).

Methods and terminology

The term epistomatous (Toon *et al.* 2015; *cf.* amphistomatous) is taken up for the soft-type leaf anatomy in which stomata, stomatal grooves, and green chlorenchyma tissues are lacking adjacent to the lateral faces of the abaxial side of the leaf blade, with a corresponding lateral increase in colourless mesophyll tissue to fill the same space. Stomata are also extremely difficult to visualise, being protected within longitudinal grooves, so this condition is usually inferred from associated structures. Epistomatous leaf blades are diagnosed externally by a lack of stomatal grooves on the adaxial surface other than in a central band, and in section by the lack of chlorenchyma tissues adjacent to the lateral adaxial surfaces. Epistomatous leaf anatomy is synonymous with the terms 'soft-type leaf anatomy' or 'centro-abaxial stomata' that are sometimes used (e.g. Mant *et al.* 2000). Use of the term 'epistomatous' for *Triodia* leaf blades is, however, slightly misleading, since stomatal grooves (and presumably also stomata) are still present on the abaxial surface but are confined to a median band.

The conclusions made here are based on morphological data, but some notes are made on relationships inferred from phylogenetic analyses of sequence alignments from ITS and ETS (Internal Transcribed Spacer and External Transcribed Spacer respectively of the nuclear ribosomal DNA region). Extraction and sequencing protocols followed those described in Anderson *et al.* (2016). Results mentioned here are based on preliminary phylogenetic trees generated using both Maximum Parsimony and Maximum Likelihood tree generation methods. Full results of these analyses will be presented elsewhere.

Taxonomy

Triodia veniciae M.D.Barrett, *sp. nov.*

Type: North of Roy Hill Station, Western Australia [precise locality withheld for conservation reasons], 25 February 2017, *M.D. Barrett* 5414 (*holo*: PERTH 08776245; *iso*: BRI, CANB, DNA, K, NSW, MEL).

Hummock-forming *perennial*, very resinous, not obviously stoloniferous; *hummocks* loose, 30–70 cm high, 40–60 cm wide; *flowering culms* 1.1–1.5 m high. *Culm internodes* 0.1–10 cm long and obscured by subtending foliage, red-brown, glabrous; aerial roots absent. *Fastigiate branching* absent. *Leaf sheaths* 2.8–5.4 mm wide near apex, surface glabrous or sparsely to moderately pilose with hairs 1.5–3.2 mm

long, resinous or not resinous, pale green to straw coloured, prominently nerved; margins (excluding orifice) glabrous; margins of orifice truncate to oblique, with a dense fringe of hairs, the longest hairs 3.5–5.5 mm long. *Ligule* a dense fringe of hairs 0.5–0.9 mm long; *pseudopetiole* obscure. *Leaf blades* flattened-V-shaped when fresh, conduplicate and tightly in-rolled when dry, initially straight but becoming somewhat curled in older and dead leaves, 20–35 cm long, 0.8–1.5 mm wide when rolled, 1.5–3 mm wide when unrolled, relatively soft when fresh, weakly pungent, glabrous abaxially and densely papillose adaxially, resinous or not over abaxial surface, bright green to dark green when fresh, dull green when dry; abaxial stomatal grooves confined to central part, 4 (2 either side of midrib), unequally spaced, absent on marginal *c.* 1/3 but the surface finely obscurely ribbed; abaxial stomatal grooves 7–8 each side of midrib; margins minutely scaberulous with prickle hairs *c.* 0.05 mm long. *Panicle* linear to ovate, 14–37 cm long, 1.0–15 cm wide, with 61–192 spikelets; primary axis minutely antrorsely scabrous, angular and ribbed; branches openly racemose with some basal branches ternate, loose, glabrous including the branch axils, non-resinous; longest basal panicle branches 5.6–15.8 cm long, sub-terete to angular, with 6–15 loosely-arranged ± uniform-sized spikelets, which are 7–16 mm apart (the distance between point of insertion of adjacent pedicels along the branch) with adjacent glumes not or slightly overlapping; *longest basal pedicels* (on longest basal panicle branches) 4.3–14 mm long, 0.1–0.2 mm wide, ± filiform, becoming slightly thicker just below spikelet, angular to slightly flattened, minutely scabrous; terminal pedicel 7–14 mm long; *Spikelet* 8–15 mm long, 1.9–3.9 mm wide, loosely 4–8-flowered with 3–7 fertile florets, sometimes with 1 apparently sterile (but possibly immature) floret at apex, narrowly elliptic to narrowly oblanceolate, compressed at maturity; lowest rachilla internode *c.* 0.8–1.7 mm long, *c.* 0.15–0.2 mm diam., glabrous. *Lower glume* narrowly lanceolate, 5.4–8.5 mm long, 1.0–1.6 mm wide, L:W 5.0–6.8, apex acute, shorter than the combined florets (including lobes), scarious, sub-membranous to chartaceous, with minute scabrosities less than 0.1 mm long over whole surface or only on margins and apex, 3–5-nerved, the midnerve distinctly raised, lateral nerves slightly raised; margins narrowly membranous, glabrous. *Upper glume* inserted *c.* 0.3–0.6 mm above lower glume, 5.0–8.5 mm long, similar to and subequal to lower glume, shorter than the combined florets (including lobes). *Lowest lemma* narrowly elliptic to narrowly lanceolate, 6.6–8.5 mm long including lobes, uniformly chartaceous, deeply 3-lobed, the midlobe somewhat drawn out into an awnlet; body 3.8–5.2 mm long including callus, 0.8–1.1 mm wide, the lower 1/2–3/4 with dense indumentum of appressed to lifting hairs 0.15–0.35(0.5) mm long arranged in 6–10 rows (or hair lines sometimes missing from the central zone), with nerves mostly obscure, but the upper part with 3 groups of 3 faint nerves visible and radiating into the lobes; midlobe 1.8–3.2 mm long, narrowly triangular at base narrowing to apex and sometimes produced into a short awnlet, similar in width to the lateral lobes; lateral lobes 1.0–2.3 mm long, 1/3–3/4 as long as midlobe, narrowly triangular at base, long-acuminate at apex but lacking a distinct awnlet, margins with a narrow membranous wing; *callus* 0.2–0.6 mm long, straight to distinctly curved in profile, attached obliquely, blunt to acute with an abruptly blunt apex in face view, acute in profile, white-bearded except in midline, the longest hairs 0.3–0.6 mm long. *Upper lemmas* similar to but smaller than lowest lemma, the midlobe becoming more awn-like toward the apex of the spikelet (i.e. the awnlet becomes a more prominent fraction of the length as lemmas decrease in size). *Palea* of basal lemma very slightly longer than lemma body, oblanceolate, 4.0–5.6 mm long, 0.6–0.8 mm wide, 2-keeled, not bitextured, membranous, glabrous or with a tuft of hairs between 1/4 and 1/2 of the length, apex acute, entire or erose; keels with a very narrow wing *c.* 0.1 mm wide, keel margins scabrous; flaps *c.* 0.15 mm wide, broadest in central part, narrower than 1/2 width of the palea body and not overlapping, entire. *Lodicules c.* 0.4 mm long, apex ± truncate, undulate, glabrous. *Anthers* 3, 1.9–2.7 mm long, exserted at maturity. *Styles* 2, *c.* 0.5–0.9 mm long. *Caryopsis* lenticular to narrowly obovate, 2.0–2.2 mm long, *c.* 0.7 mm wide, L:W 3.2–3.5:1, abruptly obtuse at apex, ± acute at base, slightly dorsiventrally flattened in section, with a broad shallow furrow on ventral side, pale reddish straw-coloured, base of styles only slightly thickened; hilum 0.55–0.65 mm long, *c.* 0.27–0.30 times as long as caryopsis. (Figure 1)

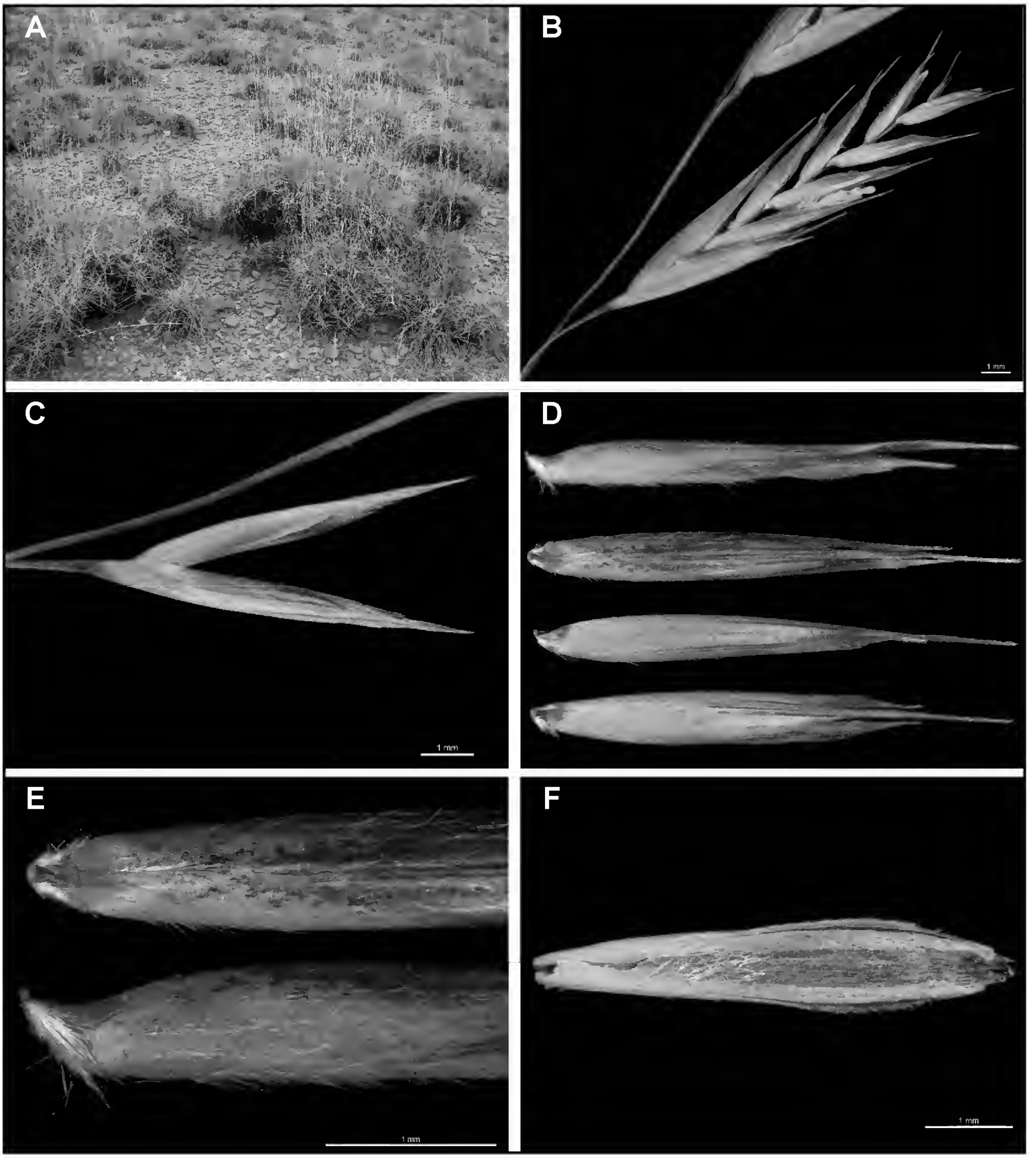

Figure 1. *Triodia veniciae*. A – flowering plants *in situ* showing habit and broken shale substrate; B – spikelet, showing the awned lemmas, variation in florets and relative midlobe (awnlet) length within a spikelet, and glumes shorter than combined florets; C – glumes, showing shape in side view; D – lemma of basal florets in side and face view showing relative proportions of body and lobes; the intense purple pigmentation in this specimen is atypical; E – base of lemma of basal floret in side and face view, showing hairs in longitudinal rows; F – palea in face view showing zone hairs in central area (paleas can also be glabrous), and very shortly winged lemma keels. Scale bars = 1 mm. Images from *M.D. Barrett* MDB 5414. Photographs by M. Barrett.

Diagnostic features. Foliage copiously resinous. Leaf sheaths glabrous or hairy on surfaces, glabrous on margins. Leaf blades epistomatous (soft-type), lacking stomatal grooves on the lateral margins of the abaxial surface. Panicles open, prominently ternately branched, lacking hairs in panicle axils. Glumes 5.4–8.5 mm long, narrowly lanceolate. Lemmas with short callus 0.2–0.3 mm long, body uniformly textured, lobes long-acute to shortly awned, the midlobe 1.8–3.2 mm long. Palea uniformly textured. Habitat restricted to shale slopes of the Chichester Range, Pilbara.

Other specimens examined. WESTERN AUSTRALIA: Chichester Range, [precise localities withheld for conservation reasons] 6 Aug. 2016, *M.D. Barrett* MDB 5408 (PERTH); 8 Aug. 2016, *M.D. Barrett* MDB 5412 (PERTH); 22 Feb. 2016, *M.D. Barrett* MDB 5415 (PERTH); 19 Mar. 2016, *M.D. Barrett* MDB 5416 (PERTH); 22 June 2017, *M.D. Barrett & N. Bezemer* MDB 5421 (PERTH); 23 June 2017, *M.D. Barrett & N. Bezemer* MDB 5424 (PERTH); 24 June 2017, *M.D. Barrett & N. Bezemer* MDB 5434 (PERTH); 25 June 2017, *M.D. Barrett & N. Bezemer* MDB 5440 (PERTH); *M.D. Barrett & N. Bezemer* MDB 5441 (PERTH); *M.D. Barrett & N. Bezemer* MDB 5442 (PERTH); 27 June 2017, *M.D. Barrett & N. Bezemer* MDB 5455 (PERTH); 27 June 2017, *M.D. Barrett & N. Bezemer* MDB 5458 (PERTH).

Phenology. Observed flowering February to March. Aseasonal fertile collections (very rare plants flowering among thousands of non-flowering plants) have been made in June and August following significant winter rainfall.

Distribution and habitat. Occurs on slopes of low hills of broken shale on the northern/eastern flanks of Marra Mamba mesa formations, along a 140 km transect of the eastern Chichester Ranges, between Roy Hill Station in the east and Mulga Downs Station in the west (Figure 2). Often occurs intermixed with or immediately adjacent to *T. epactia*. Replaced by other species such as *T. brizoides*, *T. scintillans* and *T. wiseana* on the more widespread ironstone hills in the area.

Conservation status. *Triodia veniciae* is to be listed as Priority One under Conservation Codes for Western Australian Flora (A. Jones pers. comm.). It is currently known from 27 patches, but aggregating patches of close proximity (0.1–2 km apart) consolidates the known distribution to 14 'populations', spread over a 140 km distance along an almost linear zone of the eastern Chichester Range system. These 14 populations were estimated to have a total of more than 144,500 clumps. Some of the populations are potentially under threat due to the existence of mines in close proximity to known patches. Further evidence of substantial genetic division within *T. veniciae* might also increase the protection required for the eastern genetic lineage.

Etymology. The epithet *veniciae* is after Venicia De San Miguel, from Roy Hill Environment Department, who was instrumental in the discovery, collection of type material and surveys for this species.

Affinities. Morphologically, *T. veniciae* is similar to a number of other *Triodia* species from the Pilbara. It co-occurs with the similarly resinous *T. epactia*, with which it is easily confused in the field. *Triodia epactia* (and *T. pungens* R.Br.) can be separated from *T. veniciae* by the broader ovate to elliptic glumes (L:W 1.7–4.0), glabrous sheath surfaces in *T. epactia* / *T. pungens*, and lemma hairs present only along the midline and margins, compared to lanceolate to narrowly lanceolate glumes (L:W > 5.0–6.8), frequently hairy sheath surfaces, and lemma hairs concentrated in many longitudinal rows in *T. veniciae*.

Triodia veniciae is similar to *T.* sp. Karijini (S. van Leeuwen 4111), in having narrow lemma lobes 2.0–3.2 mm long that could be interpreted as short awns, but differs in being copiously resinous (non-resinous to weakly resinous in *T.* sp. Karijini), in having paleas usually with some hairs (palea always glabrous in *T.* sp. Karijini) and 6–15 spikelets on its longest basal panicle branches (3–6 spikelets in *T.* sp. Karijini). *Triodia* sp. Karijini is only known from above 900 m on ironstone ridges on mountains in the Hamersley Range, while *T. veniciae* is only known from shale slopes in the Chichester range north of the Fortescue River (Figure 2).

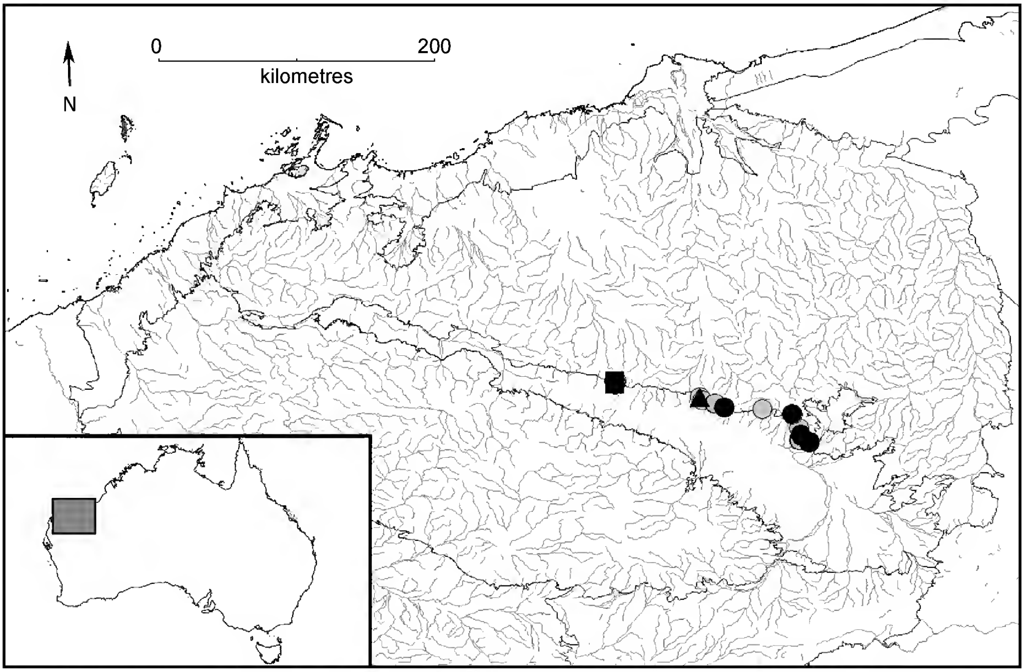

Figure 2. Distribution map of *Triodia veniciae*, showing the location of known populations along the eastern Chichester Range just to the north of the Fortescue Valley sub-region of the Pilbara bioregion. Black circles – eastern diploid populations. Black triangle – eastern tetraploid population. Black square – western population that is genetically somewhat divergent and is inferred to have a reduced-tetraploid DNA content, see text for details. Grey circles – eastern populations not assessed for ploidy.

Triodia veniciae is also similar to *T. melvillei* (to which it would key in Lazarides *et al.* 2005), sharing a very resinous habit, narrow glumes and lemma hairs concentrated in longitudinal rows. However, the lemmas are 3-awned in *T. melvillei* (lowest lemma midlobe 5.5–6.8 mm long in Pilbara specimens), compared to lobed to sub-awned with lowest lemma midlobe 2.1–3.2 mm long in *T. veniciae*. The leaf sheaths are most frequently hairy on their surfaces in *T. veniciae*, whereas they are always glabrous in *T. melvillei* (at least in hundreds of specimens seen by me, including all Pilbara specimens at CANB and PERTH, however Lazarides (1997) reports lower sheaths can be partially hirsute, without reporting specimen details nor their origin). The panicle axis and branches are strongly scabrous in *T. veniciae* but only weakly scabrous in *T. melvillei*. The distributions of *T. melvillei* and *T. veniciae* do not overlap, with *T. veniciae* restricted to the Chichester Range north of the Fortescue River, while *T. melvillei* occurs in the Pilbara south of the Fortescue River, south and east into central Australia.

The Pilbara species *T. basitricha* also has hairy leaf sheaths, but has awned lemma lobes, and lemmas bitextured with a sharp transverse demarcation line (uniformly textured in *T. veniciae*). Although both species occur in the eastern Pilbara, they are not known to occur in close proximity. Specimens of *T. veniciae* lacking florets can be distinguished by having shorter lower glumes 5.4–8.5 mm long (10–12.5 mm long in *T. basitricha*) and more numerous spikelets on longest basal branches (7–14 compared to 4–5 in *T. basitricha*).

Despite the morphological similarities of the above Pilbara species, ITS and ETS sequences (data not shown) suggest *T. veniciae* has a closer relationship to the Kimberley and Top End species *T. bynoei*. *Triodia bynoei* has distinct lemma awns, and lemma hairs scattered over the surface, not clearly concentrated in rows.

Notes. Preliminary unpublished genetic investigation suggests that there may be two genetic units within *T. veniciae*, as plants from the Mulga Downs patches (Western group, n=2) consistently differ from samples from more eastern populations (Eastern group, n=6) in three and five substitutions in ITS and ETS regions respectively (data not shown). The Mulga Downs patches also appear to have a 'reduced tetraploid' DNA content based on flow cytometric measurements of DNA content, consistent with a long-divergent tetraploid population that is in the process of becoming diploidised (Wendel 2015). Flow cytometric measurements of DNA content from populations in the Eastern group are predominantly diploid, or in one population tetraploid with a typical 2:1 ratio relative to diploid populations (M. Barrett unpublished data).

Field investigations have shown that plants in the western-most populations on Mulga Downs always have glabrous leaf sheaths, while in those around Roy Hill Station and Christmas Creek Mine always have sparsely to moderately densely hairy sheaths. In geographically intermediate areas near Cloudbreak Mine (genetically belonging to the ITS/ETS Eastern group), plants can have either glabrous or hairy sheaths, and these populations often have a mixture of the two morphotypes. As a result, the glabrous sheath character is not completely diagnostic for the Western group lineage. No other characters differing between the two groups are known, and characteristics from Mulga Downs specimens (*M.D. Barrett & N. Bezemer* MDB 5440 to MDB 5442) were always within the variation found amongst other collections made from further east.

The vernacular name Roy Hill Spinifex is suggested.

Acknowledgements

The Roy Hill Environment Department, in particular Venicia De San Miguel, Todd Bell and Susanna Beech, are thanked for providing fieldwork and logistical assistance. Roy Hill Holdings Pty Ltd provided funding for *Triodia* surveys and for the formal description of *T. veniciae*.

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SHORT COMMUNICATION

Styphelia quartzitica and *S. rectiloba* (Ericaceae: Epacridoideae: Styphelieae), two new, morphologically anomalous species of restricted distribution

Recently published research by Puente-Lelièvre *et al*. (2016) dealing with the molecular phylogeny of the large *Styphelia* Sm.–*Astroloma* R.Br. clade has led to the adoption of a greatly enlarged circumscription for *Styphelia* (Crayn *et al*. 2019). The sampling of the Western Australian taxa for that project was both relatively dense (96 taxa, or about two-thirds of the western members of the clade were sampled) and strategic, with all major morphological groups included, in addition to most of those taxa that showed no clear morphological affinities. However two uncommon species, which did not fit well with any morphological group, were not sampled. While their closer affinities are uncertain and will require further molecular investigation to resolve, there is little reason to doubt that the two are *Styphelia* in the newly expanded sense. They are described below.

Styphelia quartzitica Hislop, *sp. nov.*

Typus: Fitzgerald River National Park, Western Australia [precise locality withheld for conservation reasons], 17 May 2016, *M. Hislop* 4596 (*holo*: PERTH 08836639; *iso*: CANB, K, MEL, NSW).

Leucopogon sp. Barren Range (A.S. George 10092), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 June 2019]

Erect *shrubs* to 60 cm high and 40 cm wide, single-stemmed at ground level from a fire-sensitive rootstock. Young *branchlets* with a dense indumentum of mostly retrorse hairs, 0.05–0.20 mm long. *Leaves* spirally arranged, crowded, variably antrorse, or occasionally some leaves ± patent; apex long-mucronate, pungent, mucro 0.4–1.0 mm long; base attenuate; petiole rather obscure, 0.3–0.8 mm long, shortly hairy on adaxial surface and margins; lamina linear or very narrowly ovate, 7–14 mm long, 0.8–1.5 mm wide, flat or adaxially concave, the longitudinal axis gently incurved, usually distinctly twisted; surfaces markedly discolorous, shiny; adaxial surface shortly and sparsely hairy, ± transversely rugose, the venation not evident; abaxial surface paler, glabrous, with 5 flat or slightly raised primary veins; margins glabrous or minutely scabrid. *Inflorescence* axillary, widely spreading; axis 1.4–2.6 mm long, 1- or less often 2-flowered, ± terete in lower portion, plano-convex above the fertile node, terminating in a bud-rudiment; axis indumentum moderately dense, *c.* 0.1 mm long; flowers widely spreading, sessile. *Fertile bracts* broadly ovate to depressed-ovate, 0.4–0.6 mm long, 0.4–0.6 mm wide, subtended by 4 or 5 sterile bracts. *Bracteoles* broadly ovate to depressed-ovate, 1.0–1.3 mm long, 1.0–1.4 mm wide, obtuse; abaxial surface not keeled, glabrous, greenish, ± striate; margins minutely ciliolate. *Sepals* narrowly ovate, 2.8–3.6 mm long, 1.2–1.3 mm wide, acute or subacute, shortly mucronate; abaxial surface glabrous, pale greenish to straw-coloured, venation obscure; adaxial surface with a discrete patch of very short, sparse hairs close to the base; margins minutely ciliolate, with hairs < 0.05 mm long. *Corolla tube* cream, ± cylindrical or narrowly obovoid, longer than the sepals, 3.0–4.5 mm long, 1.7–2.2 mm wide, glabrous externally; internal surface densely hairy in a medial

https://florabase.dpaw.wa.gov.au/nuytsia/ ISSN 2200-2790 (Online) ISSN 0085-4417 (Print)

band, glabrous at base. *Corolla lobes* cream, shorter than the tube, 2.0–2.5 mm long, 1.0–1.2 mm wide at base, erect in lower 1/2–2/3 of their length and then spreading and recurved; glabrous externally, internal surface with a sparse indumentum of twisted and ornamented hairs, concentrated towards the margins. *Filaments* terete, 0.3–0.4 mm long, attached to anther 2/3–3/4 above base, adnate to tube just below sinuses. *Anthers* partially exserted from the tube (by 1/3–1/2 of their length), 1.2–1.3 mm long, apex rounded to shallowly emarginate. *Nectary* annular, shallowly lobed, 0.3–0.4 mm long, glabrous, usually grooved longitudinally below the sinuses. *Ovary* pale green, narrowly ovoid, *c.* 1.3–1.6 mm long (but refer comments under notes below), 0.6–0.8 mm wide, glabrous, 5-locular. *Style* glabrous or minutely papillose in the upper half, *c.* 2.3–3.6 mm long (but refer comment under notes below), tapering smoothly from ovary apex, with stigma presented at the top of the corolla tube; stigma not or barely expanded. *Fruit* narrowly ellipsoid or obloid, 3.2–4.0 mm long, 1.6–1.8 mm wide, much longer than the calyx; surface glabrous, with longitudinal grooves, mesocarp poorly developed; gynophore absent; style persistent. (Figure 1)

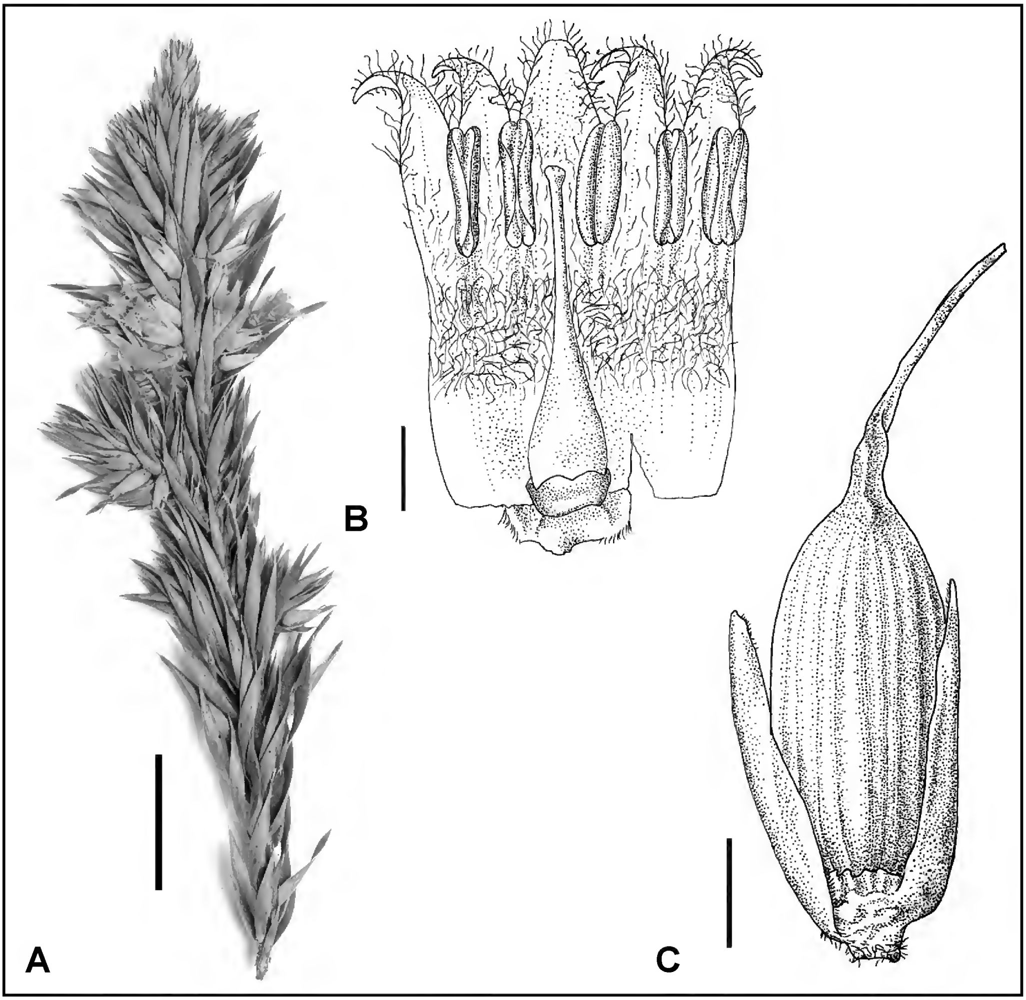

Figure 1. *Styphelia quartzitica*. A – scanned image of flowering branchlet; B – flower, slit open longitudinally; C – fruit. Scale bars = 1 cm (A), 1 mm (B & C). Vouchers: *M. Hislop* 4596 (A & B), *M. Hislop* 3040 (C). Drawings by Skye Coffey.

Diagnostic characters. Readily distinguished from all other western *Styphelia* by the following combination of characters: leaves linear, longitudinally twisted; internal surfaces of corolla lobes with a sparse indumentum concentrated towards the margins; internal corolla tubes with a medial band of dense hairs; fruit ± dry, longitudinally grooved, narrowly ellipsoid or obloid, lacking a gynophore.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 4 Aug. 1995, *S. Barrett* 323.1 (PERTH); 26 Nov. 2002, *S. Barrett* 1054 (PERTH); 9 Oct. 2007, *S. Barrett* 1648 (PERTH); 26 Mar. 2012, *S. Barrett* 2094 (PERTH); 16 July 1970, *A.S. George* 10092 (PERTH); 10 Oct. 2003, *M. Hislop* 3034 (CANB, NSW, PERTH); 10 Oct. 2003, *M. Hislop* 3040 (MEL, PERTH); 28 Nov. 2002, *M. Hislop, S. Barrett & J.A. Cochrane* MH 2876 (PERTH); 30 May 1970, *K.R. Newbey* 3164 (PERTH); 17 Sep. 2011, *D.A. Rathbone* 997 (PERTH); 22 Sep. 2011, *D.A. Rathbone* 998 (PERTH).

Distribution and habitat. Restricted to the upper slopes of quartzite hills and mountains in remote parts of the Fitzgerald River National Park within the Esperance Plains bioregion (Department of Environment 2013). Grows in shallow sandy soils over quartzite in the understory of dense heath. Commonly associated species include *Regelia velutina*, *Melaleuca lutea*, *Agonis baxteri*, *Taxandria conspicua* and *Banksia oreophila*.

Phenology. Apparently has a prolonged flowering period with a peak most likely between March and May, although flowering collections have been made as late as October. Specimens with mature fruit have been collected between July and November.

Etymology. The epithet is Latinised from quartzite and refers to the rock type on which the species is found.

Conservation status. Currently listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora under the name *Leucopogon* sp. Barren Range (A.S. George 10092). All populations of this species are conserved in the Fitzgerald River National Park. However its occurrence there is very localised and habitat-specific.

Affinities. *Styphelia quartzitica* is a very distinctive species and no close morphological affinities are apparent with any of the species-groups resolved in the recent molecular phylogenetic study (Puente-Lelièvre *et al*. 2016).

The unevenly distributed corolla lobe hairs and dense medial band of hairs in the internal corolla tube are both unusual features for the genus. The conspicuously twisted leaves are another uncommon attribute.

Notes. Because the style tapers so gradually from the ovary apex in this species the given measurements for the ovary and style lengths are necessarily imprecise.

Styphelia rectiloba Hislop, *sp. nov.*

Typus: west of Kambalda, Western Australia [precise locality withheld for conservation reasons], 23 May 2013, *M. Hislop* 4249 (*holo*: PERTH 08514054; *iso*: CANB, MEL, NSW).

Leucopogon sp. Kambalda (J. Williams s.n. PERTH 07305028), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 June 2019]

Spreading, compact *shrubs* to *c.* 1.5 m high and 1.5 m wide, branching from close to base but probably with a fire-sensitive rootstock. Young *branchlets* with a sparse to moderately dense indumentum of very short, patent hairs, < 0.05 mm long. *Leaves* spirally arranged, variably antrorse; apex long-mucronate, pungent, the mucro 0.8–2.0 mm long; base rounded to cuneate; petiole well-defined, 0.5–1.0 mm long, usually with a few hairs about the adaxial surface and margins or ± glabrous; lamina ovate to narrowly ovate, 6–11 mm long, 2.3–3.5 mm wide, strongly concave adaxially, the longitudinal axis variable, from distinctly incurved to distinctly recurved; surfaces discolorous; adaxial surface glabrous, ± glaucous on younger leaves, becoming shiny, the venation not or barely evident, often with transverse striations; abaxial surface paler, matt, with 5 usually slightly raised primary veins, openly grooved or flat between veins, glabrous or very shortly and sparsely hairy; margins glabrous, irregularly denticulate. *Inflorescence* axillary, erect; axis 2.4–3.5 mm long, 1–3(4)-flowered, ± terete basally, becoming sharply angular in flowering portion, terminating in a bud-rudiment; axis indumentum moderately dense to *c.* 0.2 mm long; flowers erect, sessile. *Fertile bracts* ovate or broadly ovate, 0.7–1.2 mm long, 0.7–1.0 mm wide, subtended by 4 or 5 sterile bracts. *Bracteoles* ovate-elliptic 1.8–2.5 mm long, 1.4–1.6 mm wide, obtuse to ± retuse; abaxial surface not keeled, shortly and sparsely hairy, greenish but often tinged brown at least in the upper half; margins glabrous or minutely ciliolate. *Sepals* narrowly ovate, 3.8–4.5 mm long, 1.4–1.7 mm wide, obtuse with a short, subapical mucro; abaxial surface shortly hairy towards apex, glabrous below, initially greenish, but soon becoming brown, at least in the distal half, venation obscure; adaxial surface glabrous; margins ciliate with hairs to 0.2 mm long, mostly towards the apex. *Corolla tube* cream, cylindrical, usually slightly shorter than, to occasionally distinctly longer than, the sepals, 3.4–4.2 mm long, 1.3–1.6 mm wide; external surface usually with a few long hairs in lines; internal surface hairy in the upper 2/3, glabrous below. *Corolla lobes* cream, shorter than the tube, erect for up to *c.* 1/4 of their length and then spreading and recurved (but refer to comment under Affinities heading below), 2.4–3.2 mm long, 0.8–1.0 mm wide at base, glabrous externally; internal surface with a rather sparse indumentum of twisted and ornamented hairs. *Filaments* terete, 0.7–0.9 mm long, attached to anther 2/3–3/4 above anther base, adnate to tube just below sinuses. *Anthers* fully exserted from the tube and held at right angles to the floral axis post-anthesis, 1.2–1.4 mm long, apex emarginate. *Nectary* partite, the scales 0.45–0.55 mm long, 0.35–0.45 mm wide, glabrous. *Ovary* pale yellow-green, globose to ellipsoid, 0.6–0.8 mm long, 0.5–0.6 mm wide, hairy, 3-locular. *Style* sparsely hairy in lower 2/3–3/4, scabrous above, 4.2–5.3 mm long, tapering smoothly from ovary apex, well-exserted from the corolla with the stigma presented well beyond the corolla lobe bases and anthers; stigma expanded. *Fruit* narrowly ellipsoid, *c.* 3.0–4.0 mm long, 1.5–2.0 mm wide (but see comment under *Notes* below), *c.* equal to the sepals, surface sparsely hairy, with irregular, raised, ribs representing the dried mesocarp; gynophore absent; style shed at or close to maturity. (Figure 2)

Diagnostic characters. Readily distinguished from all other western *Styphelia* by the following combination of characters: leaves ovate, strongly concave adaxially with irregularly denticulate margins and pungent, long-mucronate apices; corolla lobes straight and sharply reflexed on dried specimens; anthers exserted from the tube and held at right angles to the floral axis post-anthesis; ovary hairy, 3-locular, style hairy at least in the lower half; fruit narrowly ellipsoid, with a thin mesocarp, lacking a gynophore.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 13 Jan. 2006, *V. Clarke* VTC 647 (NSW, PERTH); 10 May 2012, *M. Hislop* 4194 (PERTH); 10 May 2012, *M. Hislop* 4197 (K, PERTH); 14 Dec. 2011, *J. Warden* 33627 (PERTH); May 2005, *J. Williams s.n.* (PERTH); 10 June 2013, *V. Yeomans & A. Sleep* VY 840-05 (PERTH).

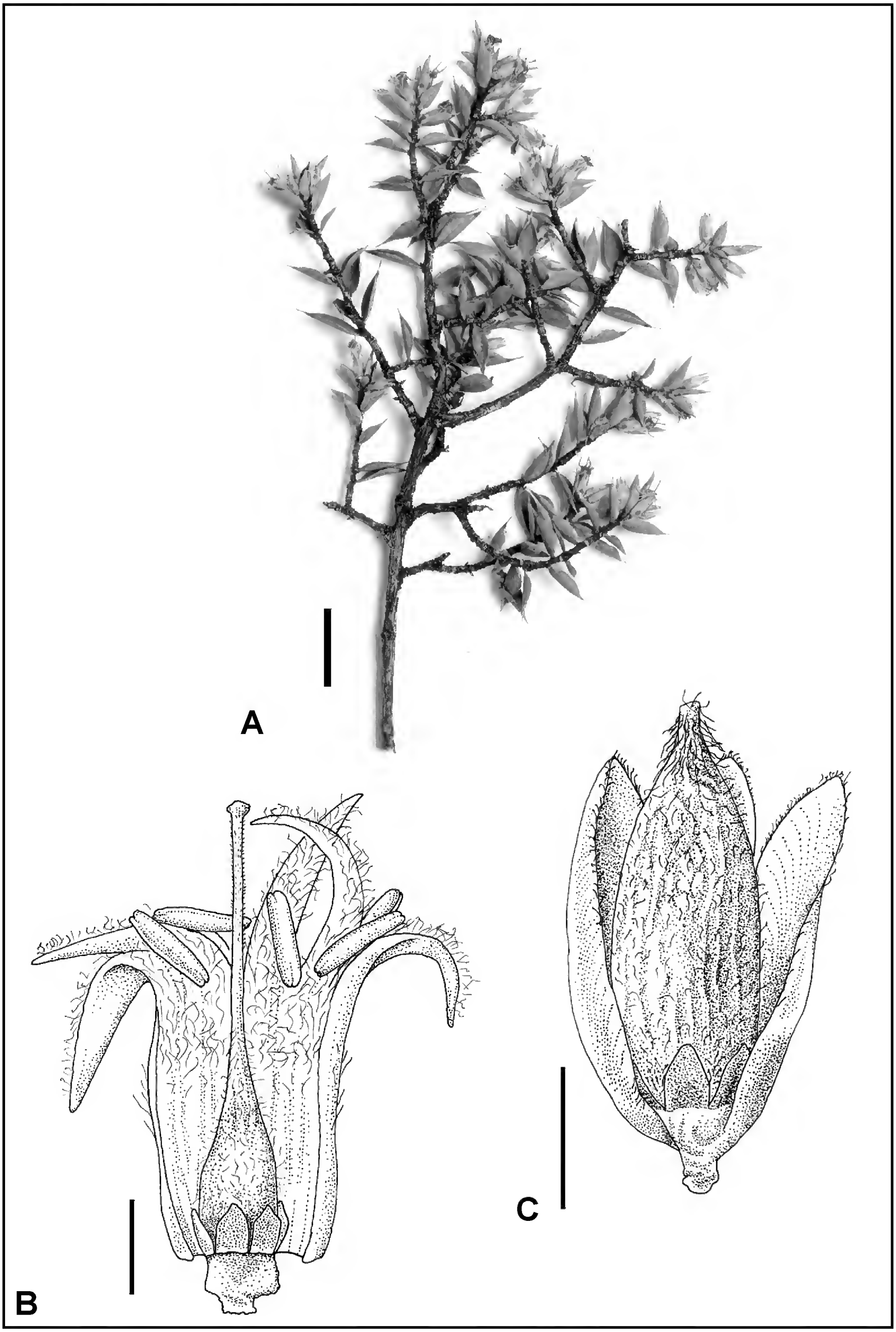

Figure 2. *Styphelia rectiloba*. A – scanned image of flowering branchlet; B – flower, slit open longitudinally; C – fruit. Scale bars = 1 cm (A), 1 mm (B & C). Vouchers: *M. Hislop* 4249 (A), *M. Hislop* 4197 (B & C). Drawings by Skye Coffey.

Distribution and habitat. Currently only known from a few populations in the Kambalda area of the Coolgardie bioregion (Department of Environment 2013) where the species is restricted to rocky, skeletal soils, on and in close proximity to, decomposed granitic breakaways. The associated vegetation is very open woodland or heath with *Eucalyptus stricklandii*, *Melaleuca leiocarpa*, *Alyxia buxifolia* and *Ptilotus helichrysoides* among the more frequently encountered species.

Phenology. Flowering specimens have been collected between December and June. The only collection to include mature fruit was made in May. Peak flowering is probably dependent on the extent and pattern of rainfall through the summer months but in average seasonal conditions it is likely to be between March and May. Fruit are likely to be present at least between May and September.

Etymology. From the Latin *recti-* (straight) and *lobus* (lobe), in reference to the noticeably straight axis of the dried corolla lobes (see *Affinities* below).

Conservation status. Listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora under the name *Leucopogon* sp. Kambalda (J. Williams s.n. PERTH 07305028). This species is localised, habitat-specific and known from very few populations. However it does occur in a remote part of the state where there is considerable potential for the discovery of new populations. Surveys are needed to better understand the extent of its distribution.

Affinities. As with *S. quartzitica* described above, *S. rectiloba* has no obvious morphological affinities with any of the species groups resolved in the recent molecular phylogenetic study (Puente-Lelièvre *et al*. 2016).

The epithet highlights an interesting feature of the species. Although there is nothing unusual in the orientation of the corolla lobes in live flowers, these being erect towards the base and then spreading and recurved above, when dried the lobes become straight and reflexed. This characteristic does not occur elsewhere in the western members of the genus. Another unusual feature relates to the disposition of the anthers. While the anthers are slightly exserted from the corolla tube at anthesis, once the pollen is shed they are held at right angles to the floral axis, and in so doing appear more prominent. The species is also notable for the presence of stylar hairs, an uncommon character in the western *Styphelia*.

Notes. The fruit measurements are based on a single fruiting collection and therefore cannot be regarded as definitive.

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Calandrinia monosperma and *C. uncinella* (Montiaceae), two new indehiscent species from Western Australia

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Abstract

Obbens, F.J. *Calandrinia monosperma* and *C. uncinella* (Montiaceae), two new indehiscent species from Western Australia. *Nuytsia* 30: 237–245 (2019). Two unique indehiscent species of *Calandrinia* Kunth. from Western Australia are described and mapped and their affinities are discussed with regards to a recent phylogeny for Australian *Calandrinia*.

Introduction

This paper describes two new annual species of *Calandrinia* Kunth. from Western Australia, both having capsules that are indehiscent and deciduous. The newly described *C. monosperma* Syeda ex Obbens is a prostrate, small to medium-sized species with a widespread distribution in the IBRA Eremaean bioregion, while *C. uncinella* Obbens is a decumbent, usually smaller-sized species of patchy distribution within the IBRA Southwest bioregion. The distinctive capsules of both these species make them readily identifiable when in fruit, however, their seeds are also quite distinctive. This is somewhat unusual, as seed shape and pattern are generally considered important diagnostic characters within the genus. Hancock *et al.*'s (2018) recent molecular phylogeny for Australian *Calandrinia*, based on a targeted gene enrichment approach, placed *C. monosperma* (as *C.* sp. The Pink Hills (F. Obbens FO 19/06)) within their clade 3 and *C. uncinella* (as *C.* sp. Piawaning (A.C. Beauglehole 12257)) within their clade 5. Two other indehiscent species, *C. disperma* J.M. Black and *Rumicastrum chamaecladum* (Diels) Ulbr. were also placed in clade 3. Both these species also have unusual and distinctive fruits; however their fruits and seeds are quite different to the above, allowing for all four indehiscent species to be quite easily recognised.

Methods

Methods used are the same as those described in Obbens (2011). In both *C. monosperma* and *C. uncinella* it is impossible to distinguish between stems and scapes. Therefore, in this paper, the term 'flowering shoot' is used to refer to the length of the stem, scape and inflorescence axis measured as one unit along the main axis of the shoot. The length of the inflorescence axis is also recorded separately.

The bioregions referred to in describing species distributions and indicated on the map are from *Australia's bioregions (IBRA)* (Department of the Environment 2013).

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Taxonomy

Calandrinia monosperma Syeda ex Obbens, *sp. nov.*

Type: Site is *c.* 3.8 km E along Talawana Track from the turnoff into Balfour Downs homestead, Pilbara region, Western Australia, 1 June 2004, *F. Obbens & B. Bromilow* FO 32/04 (*holo*: PERTH 06609740; *iso*: CANB).

Calandrinia sp. The Pink Hills (F. Obbens FO 19/06), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed June 2019].

Prostrate, sometimes slightly decumbent *annual herbs*, 10–110 mm tall, 60–385 mm wide, glabrous, the root system comprising a small taproot (occasionally larger) with several fibrous roots. *Basal leaves* succulent, narrowly linear, sometimes slightly curved inwards, 7.5–80 mm long, 1.2–3.8 mm wide, terete to subterete in mid cross-section, green to brownish-green, often turning blackish when aging. *Flowering shoots* usually 4–11(–20), 25–270 mm long, radiating from base, the proximal 10–48 mm leafless, thereafter very leafy including proximal portions of inflorescence axes, branched several times with secondary branching relatively common, each branch terminating in either a singular or branched inflorescence. *Stem leaves* fleshy, narrowly linear to narrowly elliptic, 2.5–15 mm long, 1.2–3.2 mm wide, shortly mucronate, alternate to somewhat scattered, ascending, often curved inwards, usually terete to compressed in mid cross-section, colour as above. *Inflorescences* 4–12 flowered; axis 8–140 mm long, generally forming a loose cyme or panicle, the inflorescence tip unfurling with maturity, bare except for several ± scarious bracts. *Inflorescence axis bracts* appressed, narrowly triangular, occasionally broader, 0.75–1.1 mm long, 0.4–0.55 mm wide, apex acuminate, scattered, but often located near bases of individual flower pedicels, withering when flowers reach mature fruit stage. *Pedicels* 0.1–0.2 mm long and erect, to 0.4 mm long in fruit. *Flowers* 1.5–3.0 mm diam. *Sepals* thick, broadly ovate to orbicular, 0.9–1.3 mm long, 1–1.2 mm wide, fused over a short distance to the apex of the pedicel, with a moderately prominent midvein and two lateral veins and extensive reticulation, upper edge distinctly hyaline. *Petals* 5, usually pale pink or white, narrowly elliptic to ovate, occasionally broader, 1.1–1.6 mm long, 0.6–1 mm wide, free to base. *Stamens* 3–5 in one series; filaments flattened, very broad at the base, 0.4–0.6 mm long, shortly adnate to the base of adjoining petals and attached to the top of basal ring beneath ovary; anthers orbicular to broadly elliptic in outline, 0.25–0.35 mm long, 0.25–0.35 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* obovoid, 0.55–0.7 mm diam., brown. Stigmas 3, squat, linear to narrowly triangular, lengthening and spreading with maturity, 0.15–0.3 mm long, free to base, with a dense covering of stigma trichomes. *Capsule* ellipsoid to globular, coriaceous to crustose, surface distinctly verrucose-colliculate, 1.3–1.7 mm long, 1.1–1.3 mm wide, the apex relatively obtuse, usually much longer than the sepals, capsules indehiscent and when mature also deciduous with sepals attached; valves 3, sometimes very shortly split at the apex, probably splitting fully with age. Seeds one per capsule, greyish to black, obovoid to globular with a relatively large strophiole, 1–1.05 mm long, 0.8–0.9 mm wide, 0.65–0.7 mm thick, surface minutely and parallelly rugose. (Figures 1, 2).

Diagnostic features. *Calandrinia monosperma* may be uniquely diagnosed within the genus by its distinctive hard, one-seeded, indehiscent capsules with a verrucate-colliculate surface that are unlike those of any other species of *Calandrinia*.

Other specimens examined. WESTERN AUSTRALIA: Mine Flats, Paraburdoo, 23 Sep. 1979, *K.J. Atkins* 584 (PERTH); Fish holes, 36.5 km from Doolgunna Homestead on the northern boundary of the station, 9 Aug. 2006, *G. Byrne* 2308 (PERTH); Site LMS 18, 17 km SW of Lake Mason Homestead, 21 Sep.

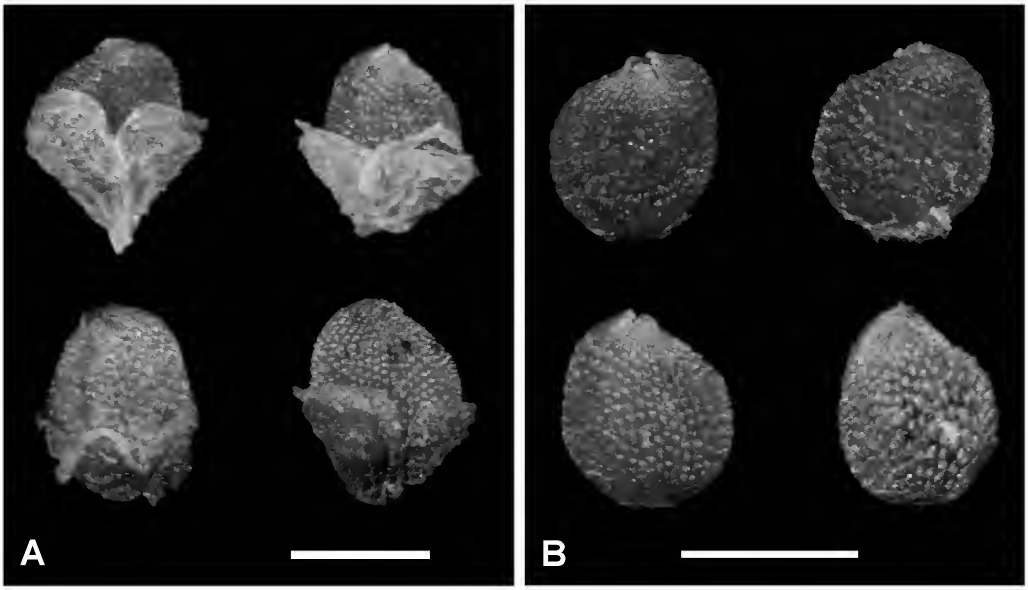

Figure 1. *Calandrinia monosperma* capsules with sepals and portion of pedicel attached (i.e. dispersal unit) (A) and capsules with sepals removed (B). Scale bars = 1 mm. Voucher: *F. Obbens & B. Bromilow* FO 32/04.

2004, *D.J. Edinger & G. Marsh* DJE 4989 (PERTH); Mount Narryer, SW of main peak, 10 Aug. 1997, *A.S. George* 17374b (PERTH); Booylgoo Range, survey site BOOY07, on Booylgoo Spring Station approximately 4.1 km SE of Number 1 Bore and 2.8 km north of Phils Bore. Approximately 62.6 km east north-east of Sandstone, 3 Sep. 2006, *A. Markey & S. Dillon* 4778 (PERTH); Jack Hills, survey site JACK35, located at the end of the main range approximately 3 km S of spot-height 482 m, and approximately 30 km from the junction of Berringarra - Cue Rd and the main track running adjacent and parallel N of the Jack Hills Range, 29 Aug. 2005, *R. Meissner & Y. Caruso* 705 (PERTH); Mt Nairn, Milly Milly Station, survey site MTNN04, *c.* 2.7 km NE of spot-height 371 m and 4.1 km E of Tardy Well, 15 Aug. 2007, *R. Meissner & G. Owen* 1690 (PERTH); Mount Barloweerie survey site MTBW04, located on Mount Barloweerie (BIA Aboriginal Reserve), *c.* 3.8 km SE of Burra Burra Well and 7.5 km SW of Pia Well. Located *c.* 134 km NNW of Yalgoo, 25 Aug. 2008, *R. Meissner & J. Wright* 2416 (PERTH); Site 702, Weld Range, 19 July 2006, *J. Naaykens* JN 702 07 (PERTH); Area *c.* 6 to 7 km E of Channar East Mine (ESE of Paraburdoo) and *c.* 0.5 km downslope from Pilbara Biological Survey site TCMBC05, 7 June 2006, *F. Obbens* FO 19/06 (PERTH); Area along track *c.* 50 km directly ESE of Paraburdoo and *c.* 4 km S of Turee Creek East Branch. Also located nearby Pilbara Biological Survey site TCMBC12, 8 June 2006, *F. Obbens* FO 22/06 (PERTH); 5.3 km N along the Cobra-Dairy Creek Rd from junction with the Carnarvon - Mullewa Rd (W side), 9 Aug. 2015, *F. Obbens* 18/15 (PERTH); 6.4 km S along Carnarvon - Mullewa Rd from junction with the Byro - Beringarra Rd. On W side of road *c.* 250 to 300 m away, 10 Aug. 2015, *F. Obbens* 19/15 (PERTH); *c.* 40-45 km N of Murchison settlement on Carnarvon - Mullewa Rd (before Curbur Homestead turnoff), 30 Aug. 2018, *F. Obbens* FO 01/18 (PERTH); Site number: 648, 6.8 km NW of Mount Hilditch, Hamersley Ranges, Fortescue Botanical District, 2 June 1997, *M.E. Trudgen* 18309 (PERTH); Foot of The Pink Hills, 17 Aug. 1973, *E. Wittwer* W 1050 (PERTH).

Phenology. The main flowering and fruiting period for *C. monosperma* is from early June through to late September. This extensive period relates to the species' wide distribution, hence flowering and fruiting occurs first in northern populations and later at more southern locations.

Figure 2. *Calandrinia monosperma* seeds with dorsal and plan views. Scale bar = 0.2 mm. Voucher: *F. Obbens & B. Bromilow* FO 32/04.

Distribution and habitat. *Calandrinia monosperma* occurs over a relatively wide area, from southern parts of the *IBRA* Pilbara subregion to the Murchison subregion, and from Gascoyne Junction-Murchison settlement areas in the west and eastwards to Wiluna-Leonora areas (Figure 3). This species is found growing in soils described as mainly red to orange-brown, clayey or sandy loams, often pebbly or rocky and frequently ironstone on various landforms that include gibber or rocky plains, moderate hill slopes and ridgelines. It is even found growing in rocky cracks above breakaways. There are a few different vegetation communities where *C. monosperma* grows, but by far, it is most often associated with open shrublands dominated by species of *Acacia* such as *A. aneura s. lat.*, *A. ramulosa*, *A. rhodiophloia*, *A. tetragonophylla* and *A. sibirica* and other taller shrubs including *Eremophila phyllopoda*, *E. flaccida*, *E. macmilliana*, *Hakea recurva* subsp. *arida*, *Senna artemisioides* subsp. *helmsii* and *Indigofera monophyla*, with a lower storey of subshrubs, grasses and annuals such as *Ptilotus obovatus*, *P. helipteroides*, *Calytrix desolata*, *Aristida contorta*, *Eriachne pulchella*, *Goodenia prostrata* and *Helipterum craspedioides* to name a few.

Conservation status. There are currently 27 collections of *C. monosperma* held at PERTH. It is certainly under-collected in many areas over its relatively broad range. It does not appear, at this stage, to be in need of any special conservation management even though numerous mining tenements occur throughout this region.

Etymology. The epithet for this species is derived from the Greek *mono–* (one–) and *–sperma* (–seeded) in reference to its one-seeded capsules.

Notes. *Calandrinia monosperma* was described by Syeda (1979) in her unpublished MSc thesis and thus was only known as a manuscript name for many years. Under the new 2005 CHAH protocols manuscript names were allocated phrase-names and so *C.* sp. The Pink Hills (F. Obbens FO 19/06) was raised, with a voucher from the location of an earlier collection near The Pink Hills (*E. Wittwer*

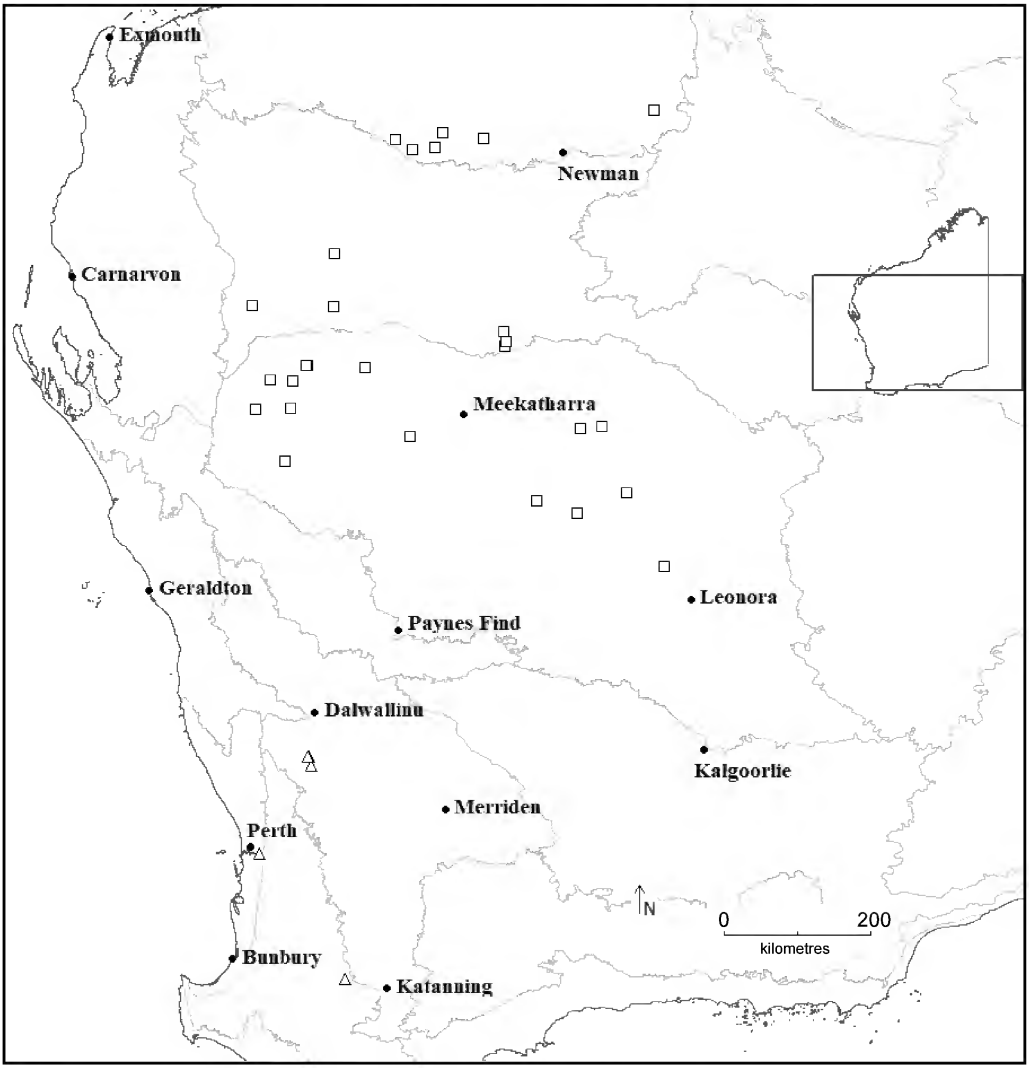

Figure 3. Distribution of *Calandrinia monosperma* (□) and *C. uncinella* (Δ) in Western Australia.

W 1050). However, Syeda's unpublished protologue in her MSc thesis cited two Western Australian specimens being Mt. Harris, 32 miles north of Agnew on road to Wiluna (*T.E.H. Aplin* 2379) and 2 miles north of Mt. Fouracre, Leonora (*B. Severne* 635395 GA). Both these collections are currently on loan to CANB, but their locations are still included on Figure 3. Most importantly, the Scanning Electron Microscope images of the diagnostic capsules of *C. monosperma* that were included in Syeda's thesis have confirmed the distinctiveness of this taxon and facilitated the accurate identification of further collections.

Apart from the unusual indehiscent capsules, *C. monosperma* has other unique characteristics. For instance, the proximal end of the filaments and the top of basal rings are not papillose, a nectary feature common to almost every *Calandrinia* species. The lack of these nectaries could indicate that self-pollination is occurring, but further study is required to confirm this.

A recent molecular phylogeny of Australian *Calandrinia* (Hancock *et al.* 2018) has *C. monosperma* placed in clade 3, a group of small-flowered, mostly prostrate annuals with usually five petals and five stamens, although some species have fewer (as low as three). Most species are several-seeded, except *C. monosperma* and the other two indehiscent species in this group, that is, *C. disperma* and *Rumicastrum chamaecladum* which are one or two-seeded. As mentioned in the introduction, all the indehiscent species are readily recognised by their unusual fruits and seeds, but like most *Calandrinia* species, these indehiscent species could be difficult to recognise from flowering material only, although habit, habitat and distribution can be of some use for identification. Surprisingly, the three indehiscent species within clade 3 are not each other's closest relatives, however, the bootstrap support for the clade and at each branch is high. *Calandrinia disperma*, however, is sister to *C. liniflora* Fenzl., while the other two indehiscent species occur on separate branches. Other members in this clade include *C.* sp. Bungalbin (G.J. Keighery & N. Gibson 1656), *C. brevipedata* F.Muell., *C.* sp. Truncate capsules (A. Markey & S. Dillon 3474) and *C. corrigioloides* Benth.

Calandrinia uncinella Obbens, *sp. nov.*

Type: east of Piawaning, Western Australia [precise locality withheld for conservation reasons], 26 August 1965, *A.C. Beauglehole* 12257 (*holo*: PERTH 06189512; *iso*: CANB).

Calandrinia sp. Piawaning (A.C. Beauglehole 12257), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed June 2019].

Decumbent to semi-erect *annual herbs*, 35–110 mm tall, 30–230 mm wide, glabrous, the root system comprising a weak taproot with numerous fibrous roots. *Basal leaves* succulent, narrowly linear, often slightly curved inwards, 4–27 mm long, 1.4–2.3 mm wide, sometimes slightly mucronate, terete to sub-terete in cross-section, green to brownish-green. *Flowering shoots* usually 2–5(–15), 24–135 mm long, radiating from base, the lower third to half usually with 2 to 4 scattered stem leaves. *Stem leaves* fleshy, narrowly linear, 2.7–18.5 mm long, 0.6–1.8 mm wide, ascending, often slightly curved inwards, terete to sub-terete in cross-section, colour as above. *Inflorescences* 2–3 flowered; axis 6–27 mm long, generally a loose cyme, bare except for 3 to several ± scarious bracts. *Inflorescence axis bracts* appressed to ± spreading, narrowly triangular, occasionally broader, 0.7–2.2 mm long, 0.3–1.1 mm wide, apex acuminate. *Pedicels* 2.7–4.8 mm long and erect, to 8 mm long in fruit and strongly reflexed. *Flowers* 3.5–5 mm diam. *Sepals* thick, ovate to broadly ovate, 1.7–2.4 mm long, 1.4–2.4 mm wide, free to base, mucronate, with an indistinct midvein and several parallel lateral veins with some reticulation. *Petals* 5, occasionally 6 or 7, creamy white, rarely light pink, narrowly obovate to obovate, sometimes broader, shallowly mucronate at apex, 2.3–3.1 mm long, 0.9–2.1 mm wide, free to base. *Stamens* 5, in one row, alternating short and long, not equally spaced; filaments free, 1.2–2 mm long, attached to the top of basal ring beneath ovary; anthers broadly elliptic to orbicular in outline, 0.3–0.55 mm long, 0.3–0.5 mm wide, versatile, extrorse, sometimes facultatively antrorse when the longest filaments fold inwards towards stigmas, dehiscing longitudinally. *Ovary* ovoid, surface bumps often noticeable, 1.1–1.25 mm diam., brown. *Stigmas* 3, squat-triangular, lengthening and spreading modestly with maturity, 0.3–0.55 mm long, on a short style 0.2–0.25 mm long, with a dense covering of short stigma trichomes. *Capsule* roughly ovoid to somewhat pyramidical, coriaceous to woody, with many upright hooked appendages protruding from the surface, 4.5–6.5 mm long, 3.5–4.5 mm wide, the apex acuminate, much longer than the sepals although the sepals usually deciduous when capsule matures, capsule indehiscent and eventually deciduous (possibly epizoochory) with pedicel attached; valves 3, probably splitting with age. Seeds 2–5 per capsule, red-brown, elongated and 'pear-shaped', sometimes compressed with a long thin strophiole, 1–2.2 mm long, 0.5–1.3 mm wide, 0.3–0.8 mm thick, surface appears smooth (but, very lightly colliculate and wrinkled at higher magnification), somewhat glossy. (Figures 4)

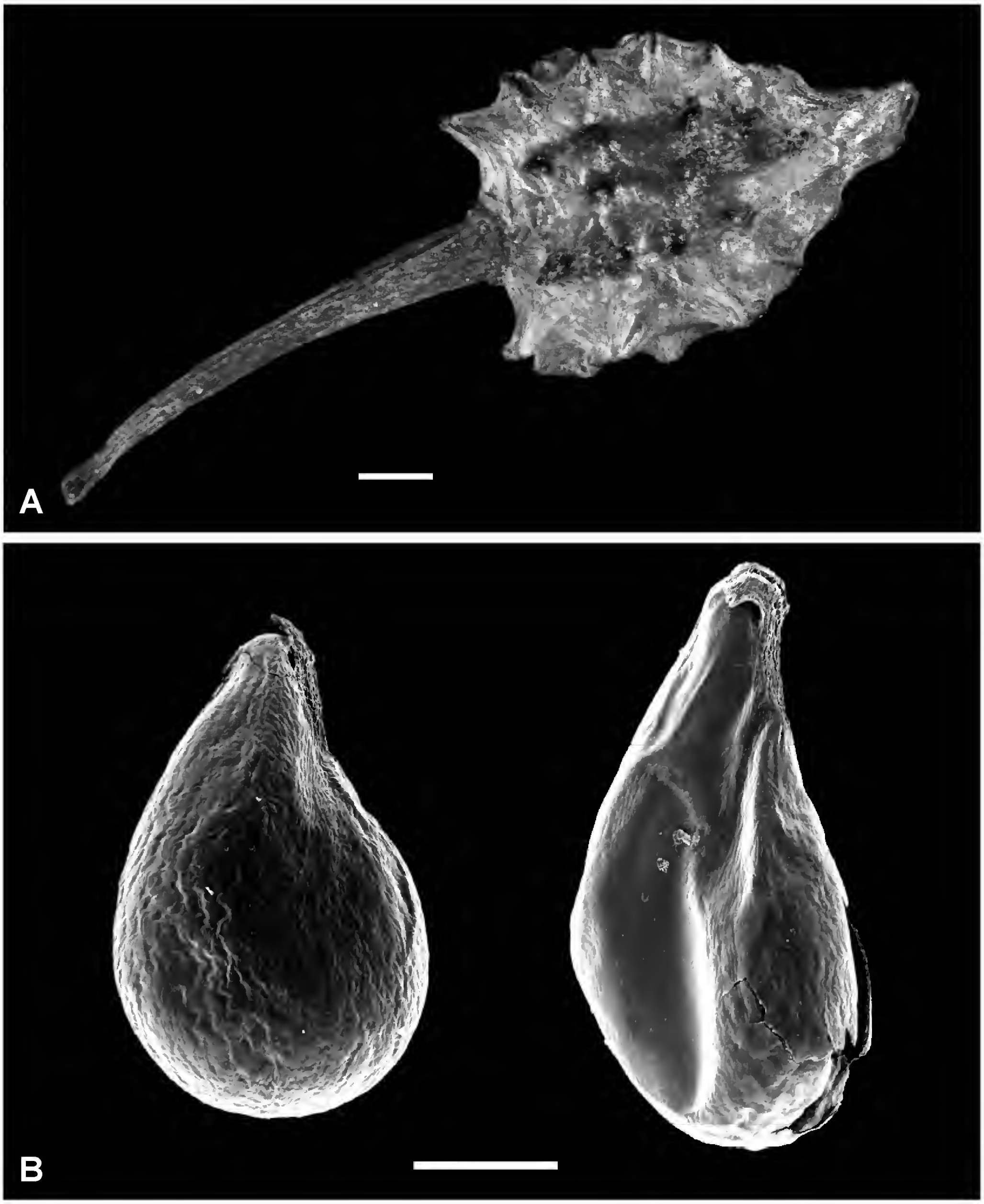

Figure 4. *Calandrinia uncinella* capsule (A) and seeds showing variation in shape and size (RH seed partially squashed within the capsule) (B). Scale bars = 1 mm. Voucher: *A.C. Beauglehole* 12257.

Diagnostic features. *Calandrinia uncinella* may be readily diagnosed within the genus by its unusual and uniquely indehiscent capsules that have numerous upright hooked appendages protruding from the surface; a feature that is not evident in any other species.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 Sep. 2013, *K.L. Brown & G. Paczkowska* KLB 1191 (PERTH); 14 Oct. 1983, *A.S. George* 16292

(PERTH); 2 Oct. 2002, *F. Obbens* 33/02 (PERTH); 16 Sep. 2003, *F. Obbens* FO 25/03 (PERTH); 1 Oct. 2014, *F. Obbens & L. Hancock* FO 01/14 (PERTH); 3 Sep. 2011, *K. Thiele* 4217 (PERTH).

Phenology. The main flowering and fruiting period for *C. uncinella* is from late August to mid-October.

Distribution and habitat. While poorly known and categorised as a species of conservation concern, *C. uncinella* occurs over a relatively wide area of the south-west of Western Australia. Most of the known collections are from within the IBRA Avon Wheatbelt subregion or closely adjacent with specimens from around the type location near Piawaning and one from south of Arthur River. Three other collections are from outer metro Perth and within the IBRA Swan Coastal Plains subregion, seemingly a strange disjunction from the wheatbelt populations (Figure 3). So far, all populations have been found in seasonally wet swamps or on saline river flats on ground or embankments just above water, growing in soils described as grey-brown sandy or silty loams or white to creamy sands over clays usually with poor drainage. Associated vegetation communities are generally low heath to shrubland with abundant herbfield understories or open spaces that occasionally include samphires. Other associated shrub species include *Melaleuca hamata*, *M. brevifolia*, *Acacia lasiocarpa*, *Hypocalymma angustifolium*, *Callitris pyramidalis*, while the herbfields include grasses, sedges and annuals such as *Eragrostis dielsii*, *Austrostipa* sp., *Gahnia trifida*, *Chaetanthus aristatus*, *Hyalochlamys globifera*, *Pogonolepis stricta*, *Gnephosis* sp., *Tribonanthes* sp., *Atriplex* sp., and some samphires such as *Tecticornia lepidosperma.*

Conservation status. *Calandrinia uncinella* is listed as a Priority One under the Conservation Codes for Western Australia Flora (Smith & Jones 2018), under *Calandrinia* sp. Piawaning (A.C. Beauglehole 12257). Presently, there are only seven collections at PERTH of this species, although its distribution could be more widespread. Sporadic searches of potential habitat have not yet succeeded in finding more populations. The existing populations are being impacted by increasing salinity and possibly a lack of vectors for spreading its indehiscent capsules (i.e. seeds). More dedicated surveys are required to determine whether the species needs increased protection.

Etymology. The epithet is derived from the Latin *uncinus* (hook, barb) and *–ellus* (diminutive) in reference to the small hooks on the capsule appendages (see Figure 4A).

Notes. *Calandrinia uncinella* falls within clade 5 of the molecular phylogeny published by Hancock *et al*. (2018), which includes a group of small-flowered, mostly decumbent annuals with five or more petals (up to seven) and generally five stamens. Most species have capsules with several to many seeds, except *C. uncinella*, which is generally two or three-seeded. Thus far, *C. uncinella* is the only indehiscent species in the group with other members including *C.* sp. Needilup (K.R. Newbey 4892), *C. holtumii* Obbens & L.P. Hancock, *C. polypetala* Fenzl, *C.* sp. Warriedar (F. Obbens 04/09), *C. granulifera* Benth. and *C.* sp. Kenwick (G.J. Keighery 10905). Also *C. uncinella*, like *C. monosperma*, lacks nectaries at the base of the filaments and on the basal rings, but this does not necessarily confirm that self-pollination is occurring. Interestingly, however, is the fact that indehiscence has evolved multiple times and independently in two different Australian *Calandrinia* clades.

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SHORT COMMUNICATION

Elevation of *Eucalyptus gardneri* subsp. *ravensthorpensis*, and notes on relationships between obligate-seeder and resprouter members of subseries *Levispermae* (Myrtaceae)

Eucalyptus subseries *Levispermae* Brooker (subg. *Symphyomyrtus*, section *Bisectae*, series *Levispermae*; Brooker 2000; the *E. redunca* superspecies of Brooker & Hopper 1991) consists of nine terminal taxa with distributions in the wheatbelt and southern coastal regions of Western Australia (Figure 1). In the revision of the broader series *Levispermae* by Brooker and Hopper (1991), five species were recognised with four of these consisting of two subspecies each. Important characters for distinguishing taxa are growth form (related specifically to whether the taxon develops a lignotuber), mature leaf colour, glossiness and width, and operculum length, noting that there is little differentiation in fruit traits (Brooker & Hopper 1991). Currently recognised taxa, noting lignotuber states, are *E. gardneri* Maiden subsp. *gardneri* (obligate-seeder), *E. gardneri* subsp. *ravensthorpensis* Brooker & Hopper (obligate-seeder), *E. densa* Brooker & Hopper subsp. *densa* (obligate-seeder), *E. densa* subsp. *improcera* Brooker & Hopper (lignotuber-resprouter), *E. pluricaulis* Brooker & Hopper subsp. *pluricaulis* (lignotuber-resprouter), *E. pluricaulis* subsp. *porphyrea* Brooker & Hopper (lignotuber-resprouter), *E. varia* Brooker & Hopper subsp. *varia* (lignotuber-resprouter), *E. varia* subsp. *salsuginosa* Brooker & Hopper (lignotuber-resprouter) and *E. redunca* Schauer (lignotuber-resprouter). Elevation

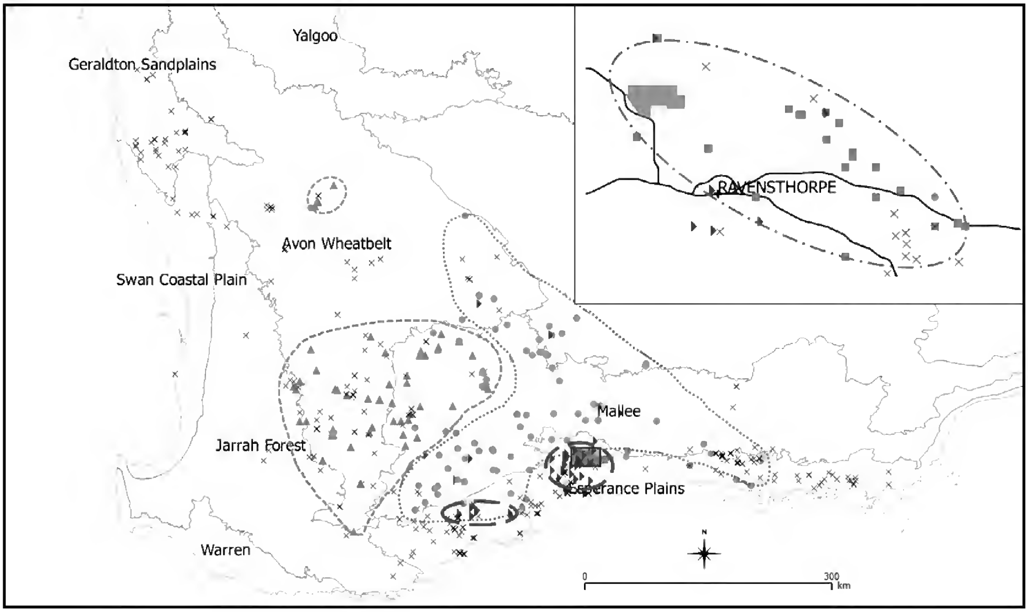

Figure 1. Distribution of specimens held in the Western Australian Herbarium as at 29 May 2019 and approximate range of *Eucalyptus ravensthorpensis* (■; dash-dot line), *E. gardneri* (▲; short-dash line), *E. densa* (●; dotted line), *E. improcera* (▶; long-dash line) and other taxa (×; all lignotuber-resprouter; *E. redunca*, *E. pluricaulis* and *E. varia*, using the taxonomy of Brooker & Hopper 1991) of the subseries *Levispermae*, in the context of IBRA Regions. The insert shows the Ravensthorpe Range area with major roads and conservation estate (shaded ■), to which *E. ravensthorpensis* is endemic.

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of *E. improcera* (Brooker & Hopper) D.Nicolle & M.E.French, along with new combinations affecting *E. pluricaulis* and *E. redunca*, were recently proposed by French and Nicolle (2019), although they cited no new data supporting these novel taxonomic arrangements.

The taxonomic concept applied by Brooker and Hopper (1991) considered morphological differences and the degree of apparent reproductive isolation when in sympatry. Of particular relevance to this paper is their treatment as subspecies of those allopatric taxa with 'minor morphological distinctions'. Thus, two subspecies with allopatric distributions were recognised in *E. gardneri* and *E. densa*, distinguished respectively primarily by differences in operculum length and growth form/lignotuber state.

In a study investigating whether lignotuber state differences (i.e. lignotuber-resprouter *vs.* obligate-seeder) between otherwise morphologically essentially identical eucalypt populations were representative of broader genetic distinctiveness, Gosper *et al.* (2019) sampled multiple individuals of multiple populations of all nine terminal taxa of *E.* subseries *Levispermae* using high-density, genome-wide markers. They found that the subseries as currently recognised was monophyletic, that taxa differing in lignotuber state formed discrete phylogenetic lineages, that all obligate-seeder terminal taxa were monophyletic and strongly differentiated from each other and all lignotuber-resprouter taxa, and hence that lignotuber state is a more strongly conserved character than other morphological differences such as leaf traits. Conversely, monophyly among many of the lignotuber-resprouter taxa within the subseries was not supported (Gosper *et al.* 2019).

Neither *E. gardneri* nor *E. densa* (*sensu lato* i.e. including *E. improcera*) were recovered as monophyletic at the species level in phylogenetic trees (Figure 2; Gosper *et al.* 2019). Gosper *et al.* (2019) found high levels of bootstrap support for monophyly of the ancestor of *E. gardneri* subsp. *ravensthorpensis* as one of the two earliest branches of *E.* subseries *Levispermae* (outgroups included *E. clivicola* and *E. phaenophylla* from the series *Levispermae*). The next branch, again with high support, separated hypothesized ancestors of the two remaining obligate-seeder members of the subseries (*E. gardneri* subsp. *gardneri* and *E. densa* subsp. *densa*) from those of the lignotuber-resprouter taxa, including *E. densa* subsp. *improcera*. *Eucalyptus gardneri* subsp. *gardneri* and *E. densa* subsp. *densa* were recovered as monophyletic with strong levels of support. These results were reflected in levels of divergence in Principal Coordinate Analysis (PCoA) of genetic variation.

The combination of consistent morphological trait differences and the genetic results described above lead us to conclude that the appropriate taxonomic treatment is for the two subspecies within *E. gardneri* and *E. densa* (*sensu lato*) to be recognised at the species level; as *E. gardneri*, *E. ravensthorpensis*, *E. densa*, and *E. improcera*. An argument could be made that the paraphyly or polyphyly (depending on tree construction method) of *E. improcera* with some other lignotuber-resprouter members of the subseries, but with whom it is morphologically distinct (Gosper *et al.* 2019), also demands re-assignment of these taxa. However, the absence of clear correlation between morphological characters and genetic relationships among lignotuber-resprouter members of the subseries *Levispermae* (Gosper *et al.* 2019) renders taxonomic decisions concerning these entities problematic. Other studies using high-density genetic markers in eucalypts have similarly recovered non-monophyletic arrangements between populations of currently recognised terminal taxa (Jones *et al.* 2016; Rutherford *et al.* 2016), bringing into focus the challenge of integrating traditional and phylogenomic taxonomic approaches in *Eucalyptus*. Recent and ongoing speciation, incomplete lineage sorting, introgression and/or hybridisation have been reasons proffered for the lack of commonality between *Eucalyptus* genomic phylogenies and morphology-based taxonomic arrangements (Larcombe *et al.* 2015; Bradbury *et al.* 2016; Jones *et al.* 2016). Consequently, we tentatively retain *E. improcera* as a distinct entity pending further taxonomic research, supporting its elevation by French and Nicolle (2019).

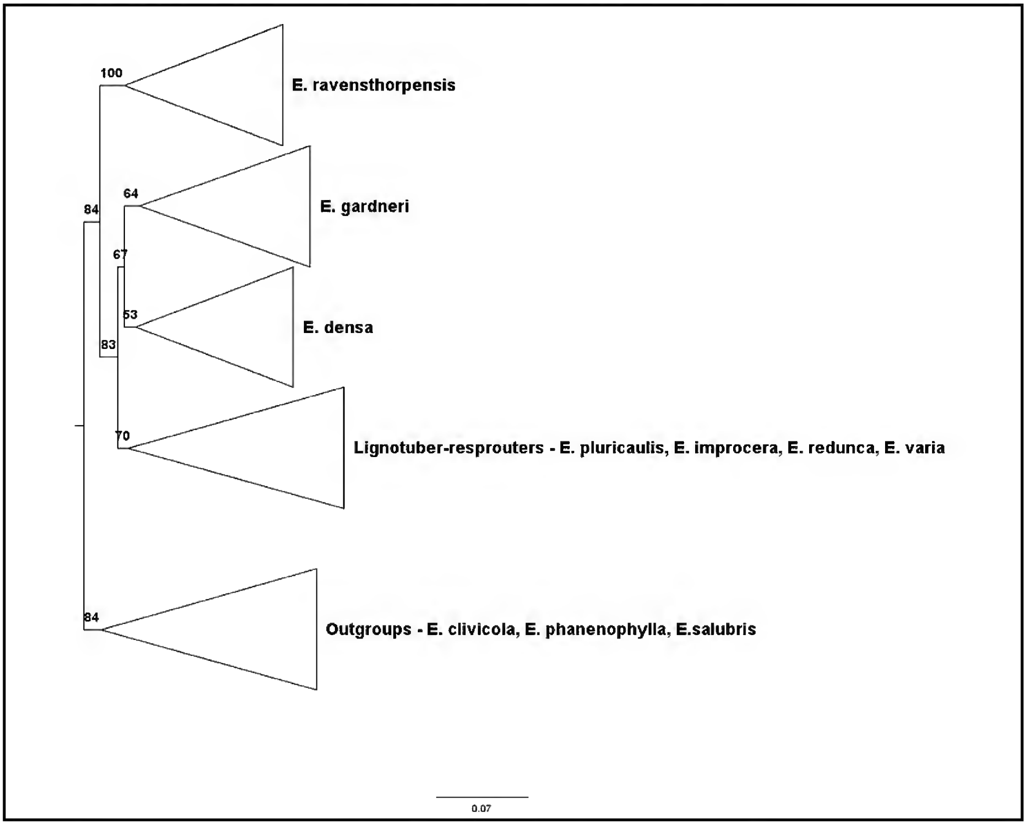

Figure 2. Simplified phylogenetic tree of *Eucalyptus* subseries *Levispermae* based on genomic DNA sequenced using DArTseq and produced using maximum likelihood (see Gosper *et al.* 2019 for more details). Numbers above branches show bootstrap percentages and triangles at the tips of the tree represent clades containing multiple samples of the same taxon or taxa, noting that for the clades 'Outgroups' and 'Lignotuber-resprouters' (using the taxonomy of Brooker & Hopper 1991 excepting *E. improcera*) not all taxa within each clade reconstructed as monophyletic at the taxon level.

The position of the *E. ravensthorpensis* clade as sister to all others in the subseries *Levispermae* in the phylogenetic trees presented by Gosper *et al.* (2019) supports the proposition of Brooker and Hopper (1991) that the species may be a relictual taxon within the subseries (Figure 2). *Eucalyptus ravensthorpensis* has shorter opercula than all other members of the subseries but similar to taxa of the broader series *Levispermae* (Brooker & Hopper 1991; Gosper *et al.* 2019) (Figure 3C). After the node separating the ancestor of *E. ravensthorpensis*, long opercula appear to have evolved in the subseries *Levispermae* and were subsequently retained in all other taxa. Further, *E. ravensthorpensis* is restricted to the Ravensthorpe Range; a centre of diversity for the series *Levispermae* and within the richest area for eucalypts nationally (Brooker & Hopper 1991; González-Orozco *et al.* 2014; Figure 1). Significantly for a putatively relictual taxon, the Ravensthorpe Range provides a complex mixture of ancient lateritic, greenstone, mafic and ultramafic uplands (OCBILs) with more recently derived colluvial slopes, with topographic intricacies producing fine-scale variation in water availability and disturbance regimes (Hopper 1979, 2009; Markey *et al.* 2012).

These four taxa have largely allopatric distributions in the Ravensthorpe area and north into the southern and central wheatbelt (Figure 1). Taxon, distribution and habitat descriptions, and diagnostic features, outlined in Brooker and Hopper (1991) remain valid.

Figure 3. *Eucalyptus ravensthorpensis*. A – habitat on breakaways of the Ravensthorpe Range; B – tree (obligate-seeder) habit in situ; C – leaf and bud morphology, noting the less elongate opercula than other members of the subseries *Levispermae*. Images of *C.R. Gosper* CRG 0008, *S.M. Prober & C.J. Yates* (B, C). Photographs by C.R. Gosper.

Eucalyptus ravensthorpensis (Brooker & Hopper) C.R.Gosper & Hopper, *comb. et stat. nov.*

Eucalyptus gardneri subsp. *ravensthorpensis* Brooker & Hopper, *Nuytsia* 8(1): 145 (1991). *Type*: Ravensthorpe Range, ca. 5 km E of Ravensthorpe, 800 m ENE of Highway 1 along Carlingup Road, then 800 m NNW to regenerating gravel pit [Western Australia], 10 April 1991, *S.D. Hopper* 7929 (*holo*: PERTH 07534701; *iso*: CANB 687856, MEL 2340062, NSW 595295).

Selected specimens: WESTERN AUSTRALIA [localities withheld for conservation reasons]: 7 Apr. 1995, *M.I.H. Brooker* 12204 W (AD, CANB, NSW, PERTH); 14 Mar. 2017, *C.R. Gosper* CRG 0008, *S.M. Prober & C.J. Yates* (PERTH) (Figure 3); 14 Mar. 2017, *C.R. Gosper* CRG 0009, *S.M. Prober & C.J. Yates* (PERTH); 14 Mar. 2017, *C.R. Gosper* CRG 0010, *S.M. Prober & C.J. Yates* (PERTH); 14 Mar. 2017, *C.R. Gosper* CRG 0011, *S.M. Prober & C.J. Yates* (PERTH); 7 Jan. 2008, *L.S.J. Sweedman* 7313 (K, PERTH).

Conservation status. Recently re-listed as Priority Four under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *E. gardneri* subsp. *ravensthorpensis*. Restricted in distribution to the Ravensthorpe Range and recognised as a short-range endemic taxon, although locally abundant in suitable habitat (Markey *et al.* 2012). Known from Overshot Hill NR (Markey *et al.* 2011; French & Nicolle 2019; although no PERTH specimens from this location; Figure 1). All populations occur in areas prospective for mining.

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Nomenclatural updates and a new species of annual *Hydrocotyle* (Araliaceae) from Western Australia

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Abstract

Perkins, A.J. Nomenclatural updates and a new species of annual *Hydrocotyle* (Araliaceae) from Western Australia. *Nuytsia* 30: 253–277 (2019). This treatment deals with five annual Western Australian species of *Hydrocotyle* L. and is based on the outcomes of a recent molecular phylogenetic study combined with a re-evaluation of schizocarp morphology. *Hydrocotyle perplexa* A.J.Perkins is newly named, *H. intertexta* R.Br ex A.Rich. is reinstated, and the three other species covered are *H. glochidiata* Benth., *H. scutellifera* Benth. and *H. tetragonocarpa* Bunge. Three taxa are placed in synonymy: *H. blepharocarpa* F.Muell. under *H. scutellifera*, *H. pilifera* Turcz. under *H. intertexta* and *H. hispidula* var. *tenella* Benth. under *H. perplexa*. Lectotypes are selected for five of these names, and full descriptions, distribution maps and images are provided for all five species. Details of the history of recognition of these species, and a series of misapplications of names, are also given.

Introduction

Hydrocotyle L. (Araliaceae) is a genus of 35 annual and *c.* 95 perennial mesophyllous herbs, of which an estimated 58 species occur in Australia (Perkins 2019a). All species have a laterally flattened, dry schizocarpic (bicarpellate) fruit (Perkins 2019b). The annual species are endemic to Australia, and 28 of them are found in Western Australia. Most annual *Hydrocotyle* are ephemeral, often visible above ground for only a few months each year. Species such as *H. alata* A.Rich., *H. callicarpa* Bunge and *H. diantha* DC. are widely distributed in a variety of habitats including coastal and inland swamps, damp depressions in woodlands, margins of inland lakes and moss swards on granitic rocks. Other species are relatively specific to certain habitats; for example *H. hispidula* Bunge and *H. tetragonocarpa* Bunge grow in coastal areas on calcareous sands or limestone; *H. asterocarpa* A.J.Perkins, *H. decorata* A.J.Perkins and *H. spinulifera* A.J.Perkins grow on the margins of inland saltwater lakes; and the aquatic species *H. lemnoides* Benth. grows in the shallows of freshwater swamps.

Taxonomic studies and treatments of Western Australian *Hydrocotyle* (e.g. Bentham 1867; Wheeler 1987; Wheeler *et al.* 2002; Perkins 2017a,b; Perkins & Dilly 2017) have traditionally considered fruit characters to be important in delineating annual species, with the assumption that discrete phenotypes in mericarp shape and surface ornamentation correspond to separate, definable taxa. However, a recent molecular phylogenetic study (Perkins 2019a), with a strong representation of annual *Hydrocotyle*, suggested two cases where fruit polymorphy does occur within species. That study identified two well-supported clades, one comprising annual species with ebracteate flowers, and the other comprising annual and perennial species with bracteate flowers. Within the 'bracteate clade', two well-supported

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clades were recovered with one clade comprising only perennial species, and the other clade comprising only annual species. Four conclusions of taxonomic consequence in that study were:

1. *Neosciadium* Domin and *Hydrocotyle* are congeneric;

2. Specimens referable to *Hydrocotyle* sp. Hamelinensis (G.J. Keighery s.n. PERTH 02391325) and *H. tetragonocarpa* are conspecific;

3. *Hydrocotyle* sp. Puberula (H. Eichler 22058) and individuals identified therein as *H. scutellifera* Benth. are conspecific;

4. *H. blepharocarpa* F.Muell. requires circumscription to include individuals with glabrous mericarps, incorrectly assigned by some authors to *H. scutellifera*.

Perkins (2019a) dealt only with the lectotypification of *H. glochidiata*, thus, the application and circumscription of various names available for other clades of *Hydrocotyle* still required evaluation. The current paper addresses these issues. It provides full descriptions, notes on typifications, distribution maps and images for the five annual species covered.

Methods

Updated taxonomic descriptions are based on a comprehensive sample of fertile herbarium voucher specimens housed at PERTH, MEL, NSW and CANB. Vegetative and floral characters were measured from herbarium material using a dissecting microscope and the morphological terminology used in this study follows that of Perkins (2018a–c). Distribution maps for each species were produced from voucher specimen data held at PERTH, MEL, NSW and CANB, using QGIS Version 3.6.2, and they include the Interim Biogeographical Regionalisation for Australia (IBRA) Version 7 boundaries (Department of the Environment 2013). Habitat and phenology data were collected from herbarium labels and field observations. Images of type specimens were viewed via *Global Plants* (https://plants.jstor.org/).

History of species recognition and misapplied names

Collections of the species named herein as *H. perplexa* A.J.Perkins were first made by Robert Brown from King George III Sound [Albany], Western Australia in 1801. Brown assigned the manuscript name '*Hydrocotyle intertexta*' and provided two duplicates, with associated descriptive notes, to French botanist Achille Richard, who formally described this material in his monograph of *Hydrocotyle* (Richard 1820). Brown's syntypes of *H. intertexta* R.Br. ex A.Rich., retained by Richard (now held at P), were part of a mixed gathering of two taxa, the second one represented by specimens held at BM, K and MEL (now attributable to *H. perplexa*). *Hydrocotyle intertexta* was not illustrated in Richard's 1820 monograph and the protologue may have been interpreted as also encompassing the morphology of the duplicates held at K and BM. The key distinguishing character for *H. intertexta* described in the protologue (and annotated by Brown on the syntypes now held in P) is the possession of persistent, undivided carpophores. The carpophores are acerose and distinct in syntypes seen by Richard. The material (not seen by Richard) at BM, K and MEL, also has persistent carpophores but they are filiform and fragile, making them difficult to see with the naked eye, or they readily become detached (missing) from the pedicels due to their fine, fragile structure. Misinterpretation of the fruit morphology on these collections apparently contributed to subsequent misapplications of the published name by George Bentham and Ferdinand von Mueller (Bentham 1867; Mueller 1883).

In his flora treatment of *Hydrocotyle*, Bentham (1867: 340) listed Robert Brown's gatherings of *H. intertexta* under *H. hirta* R.Br. ex A.Rich. This misapplication was due (in part) to the specimens held at BM and K, being a different species to the syntypes held at P, which Richard viewed to formulate the protologue of *H. intertexta*. The application of the name *H. intertexta* is restricted herein to the Paris syntypes, with the exclusion of the BM, K and MEL specimens. As a result, the later named *H. pilifera* Turcz. (Turczaninow 1849) is reduced to a synonym of *H. intertexta s. str.* The misapplication of this entity by Bentham was also due to his failure to observe the remaining filiform carpophores on the '*H. intertexta* syntype', and he deemed it a 'variety of *H. hirta*'. *Hydrocotyle hirta* is readily distinguished from *H. perplexa*, in being villously hairy on stems, leaves and peduncles (all glabrous in *H. perplexa*), its lack of persistent carpophores and in being perennial.

Later in the same treatment, Bentham (1867: 343) recognises *H. hispidula* var. *tenella* Benth. from a gathering originating from the Warren River and provided by F. von Mueller (K 000686147). Its schizocarps share the 'granular-tuberculate' mericarp surfaces of *H. hispidula* but Bentham describes this specimen as more slender and diffuse, with less lobed leaves and shorter petioles, providing justification for assigning this voucher to varietal rank. Following the publication of Bentham's treatment, herbarium specimens with papillate fruit and slender glabrous stems were curated under *H. hispidula* var. *tenella*, including a 'syntype of *H. intertexta*' (collected by Brown) that was incorporated into the collections of the National Herbarium of Victoria (MEL 7978) by Mueller. It was not until 1961 that Hansjörg Eichler recognised that the MEL type of *H. hispidula* var. *tenella* was the same entity as the '*H. intertexta* syntypes' held at K and BM, based on his annotated determinations on K 000686147 and K 000686148. Later in 1962, Eichler also realised that the syntypes of *H. intertexta* held at P, were a different taxon (assignable to *H. pilifera*) and subsequently proposed the manuscript name *H. puberula* ms (later known as *H.* sp. Puberula (H.Eichler 22058)) for the MEL entity.

In my recent molecular phylogenetic study (Perkins 2019a), it was shown that sampled specimens of *H.* sp. Puberula (H. Eichler 22058) and '*H. scutellifera*' were conspecific and that the schizocarp surfaces were polymorphic, either glabrous or papillate. However, the latter name was misapplied, as a re-examination of the syntypes of *H. scutellifera* in the current study revealed them to represent a glabrous, scutellate fruit morph of the later-named *H. blepharocarpa*, which typically has orbicular, scutellate schizocarps, fringed with bristly trichomes. As a result, *H. scutellifera* is re-circumscribed herein, with *H. blepharocarpa* newly placed into synonymy. The new species *H. perplexa* is provided to accommodate specimens previously assignable to *H.* sp. Puberula, plus the specimens with glabrous, elliptic schizocarps that were previously misidentified as *H. scutellifera* (*sensu* Perkins 2019a). Figure 1 shows a modified version of the figure presented by Perkins (2019a: 135), updated to show the names now accepted for the five species described herein and with their synonyms added.

Taxonomic descriptions

Hydrocotyle glochidiata Benth., *Fl. Austral.* 3: 346 (1867). *Centella glochidiata* (Benth.) Drude, *Nat. Pflanzenfam.* [Engler & Prantl] 3(8): 120 (1897). *Neosciadium glochidiatum* (Benth.) Domin, *Beih. Bot. Centralbl.* 23: 291–292 (1908). *Type*: [Swan River] Western Australia, [1844], *J. Drummond* 4th coll. n. 247 (*lecto*: K 000686118 image!, *fide* A.J. Perkins, *Mol. Phylogen. Evol.* 134; 139 (2019); *isolecto*: G 00367075 image!, G 00367069 image!, LE 00015624 image!); [Swan River] Western Australia, *s. dat.*, *J. Drummond* n. 104, 105 (*syn*: K 000686117 [n. 104] image!, K 000686116 [n. 105] image!).

Annual herbs 2–9 cm high, 1–18 cm wide, with 2–6 basal leaves and branched stems bearing leaves and spicate inflorescences. *Stems* erect to ascending, pale green to yellowish green, terete, glabrous. *Stipules* white to pale cream, reniform to broadly ovate, 1.0–3.0 mm long, 0.5–2.5 mm wide, membranous,

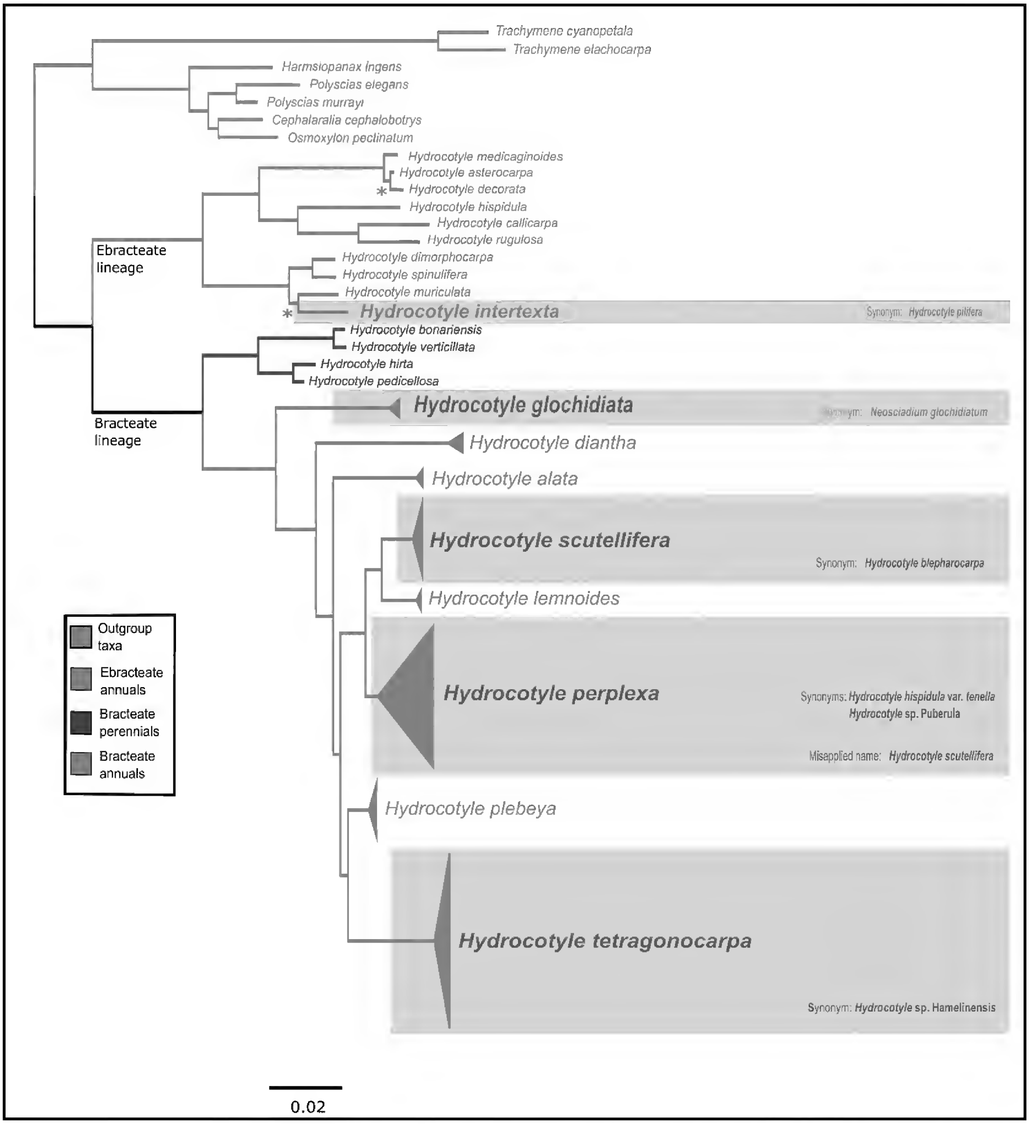

Figure 1. Phylogenetic reconstruction of *Hydrocotyle* and its closely related genera within the Araliaceae based on the nuclear marker ETS, chloroplast markers *psb*A–*trn*H and *trn*L–*trn*F, and the coded indels. The Bayesian majority-rule consensus tree is shown with posterior probabilities values < 0.95 indicated with an asterisk (*) next to the branches. Taxa dealt with in this paper are shown in bold font and highlighted in pale yellow. Synonyms and misapplied names are shown to the right of the highlighted taxa. Phylogram adapted from Perkins (2019a: Figure 2).

translucent, entire to undulate along margins. *Petioles* 2–20 mm long, glabrous. *Leaf blades* simple, dorsiventral, concolorous, carnose, oblanceolate to cuneate, 1.5–15.0 mm long, 1.5–10.0 mm wide, glabrous. *Leaf margins* toothed; teeth 3–7, rounded to obtuse. *Inflorescences* leaf-opposed, spicate, 10–30-flowered. *Peduncles* terete, shorter than subtending leaf, 2–14 mm long, glabrous. *Rachis* 1.5–7.0 mm long, subglabrous with scattered wiry hairs. *Floral bracts* spathulate, spreading with upcurved apices, persistent, 0.3–0.8 mm long. *Pedicels* 0.1–0.2 mm long. *Flowers* all bisexual, protandrous, densely arranged along the rachis appearing sessile. *Sepals* absent. *Petals* 5, white, ovate, induplicate 0.5–0.8 mm long, 0.4–0.6 mm wide; midvein sulcate on abaxial surface. *Filaments* pale

cream, *c.* 0.3 mm long. *Anthers* creamy yellow or pale crimson, elliptic, *c.* 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, elliptic. *Schizocarps* elliptic, symmetrical, becoming inflated, transversely elliptic, hispid with glochidiate hairs arranged in longitudinal rows; mericarps pale green turning pale orange to dark reddish brown at maturity; commissure 95–100% the length of mericarps. *Mericarps* 1.0–1.2 mm long, 0.5–0.6 mm wide, inflated and with a cavity at maturity when mericarps disarticulate; dorsal rib raised, acute; lateral ribs raised, acute, strongly incurved towards median ribs, lined with a row of glochidiate hairs; median ribs not raised; mericarp surface between dorsal and lateral ribs initially convex then becoming concave at maturity, with 2 longitudinal rows of glochidiate hairs; surface between lateral and median ribs concave, with a longitudinal row of glochidiate hairs adjacent to median ribs. *Carpophores* not persistent. *Fruiting styles c.* 0.2 mm long, erect to incurved. *Cotyledons* elliptic to oblanceolate in the seedlings. (Figure 2)

Diagnostic features. *Hydrocotyle glochidiata* can be distinguished from all other species of *Hydrocotyle* by a combination of the following characters: succulent annual herbs with glabrous stems and leaves; leaf blades concolorous, oblanceolate to cuneate; flowers with white petals, arranged in dense spicate inflorescences subtended by spathulate floral bracts (Figure 2E).; mature schizocarps elliptic, symmetrical, becoming inflated, transversely elliptic, hispid with glochidiate hairs arranged in longitudinal rows (Figure 2C,D); carpophores not persistent.

Selected specimens examined. WESTERN AUSTRALIA: edge of salt lake 5.3 km ESE of Morawa on Jones Lake Rd, 20 Sep. 2008, *R.L. Barrett, M.D. Barrett & C. Karsten* RLB 5125 (PERTH); north eastern edge of Lindsay Gordon Lagoon, Lorna Glen Station, 30 July 2006, *G. Byrne* 2266 (PERTH); Lake Annean, 45 km S of Meekatharra, 12 Sep. 1986, *R.J. Chinnock* 7120 (CANB, PERTH); salt lake SW of Winchester, 30 Sep. 1982, *J. Coleby-Williams* 120 (PERTH); south-east end of Hutt Lagoon, 30 Aug. 1983, *R.J. Cranfield* 4010 (PERTH); 4 km S of Coorow, 11 Sep. 1985, *Hj. Eichler* 23679 (CANB, PERTH); airstrip flat on Dirk Hartog Island, 3 Sep. 1972, *A.S. George* 11436 (CANB, PERTH); *c.* 3 km SSW of Mount Narryer Homestead, 27 Aug. 1996, *A.S. George* 17281 (PERTH); salt lake on E side of Midland Rd, Marchagee Nature Reserve, 3 Oct. 2000, *N. Gibson* 4424 (PERTH); E of Lake Moore and *c.* 60 km S of Paynes Find and 15 km N of Mouroubra homestead, 7 Oct. 1991, *W. Greuter* 22613 (PERTH); Little Lagoon 2 km E of Denham, 28 Aug. 1989, *G.J. Keighery* 10557 (PERTH); Birrida Tamala Station 4.8 km S of homestead, 20 Aug. 1995, *G.J. Keighery & N. Gibson* 953 (PERTH); Lindsay Gordon Lagoon, 5 Sep. 2003, *K.F. Kenneally & D.J. Edinger* K12531 E3730 (PERTH); Weelarrana Station, 80 km SSE of Newman, 16 km SW of Weelarrana Station homestead, 5.5 km SW of Weelarrana Hill, at central northern edge of the lake, 30 Aug. 2016, *M.N. Lyons & R.A. Coppen* FV0724 (PERTH); 4.5 km SSE of Boorabbin, 27 Aug. 1981, *K.R. Newbey* 8695 (PERTH); southern end of Lake Macleod, 6.9 km along Blowholes Rd from the North West Coastal Hwy, 18 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH, SYD); salt lake in Marchagee Nature Reserve 9 km S of Coorow, 15 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH, SYD); Muggon Station 8.2 km W of homestead, 4 Sep. 1999, *S. Patrick et al.* 3128 (PERTH); 30.5 km W of Jaurdi Station Homestead access track off the Trans-Australian Rail line, 11 Oct. 1999, *L.W. Sage & F. Hort* 2162 (PERTH); Hamersley Lakes 16 km S of Mt Jackson Homestead, 7 Oct. 1983, *P.S. Short* 1994 (CANB, MEL, PERTH); 7.2 km from Bunjil along main road to Latham, 23 Oct. 1983, *P.S. Short* 2185 (CANB, MEL).

Phenology. This species is a winter annual, with flowering and fruiting occurring from August to October.

Distribution and habitat. *Hydrocotyle glochidiata* is widely distributed in Western Australia, from the Moora region in the south-west, Boorabbin in the south-east, Weelarrana Station in the north-east and the Carnarvon region in the north-west (Figure 3). This annual species grows in damp sandy soils associated with saltpans and shorelines of saline lakes (Figure 2F).

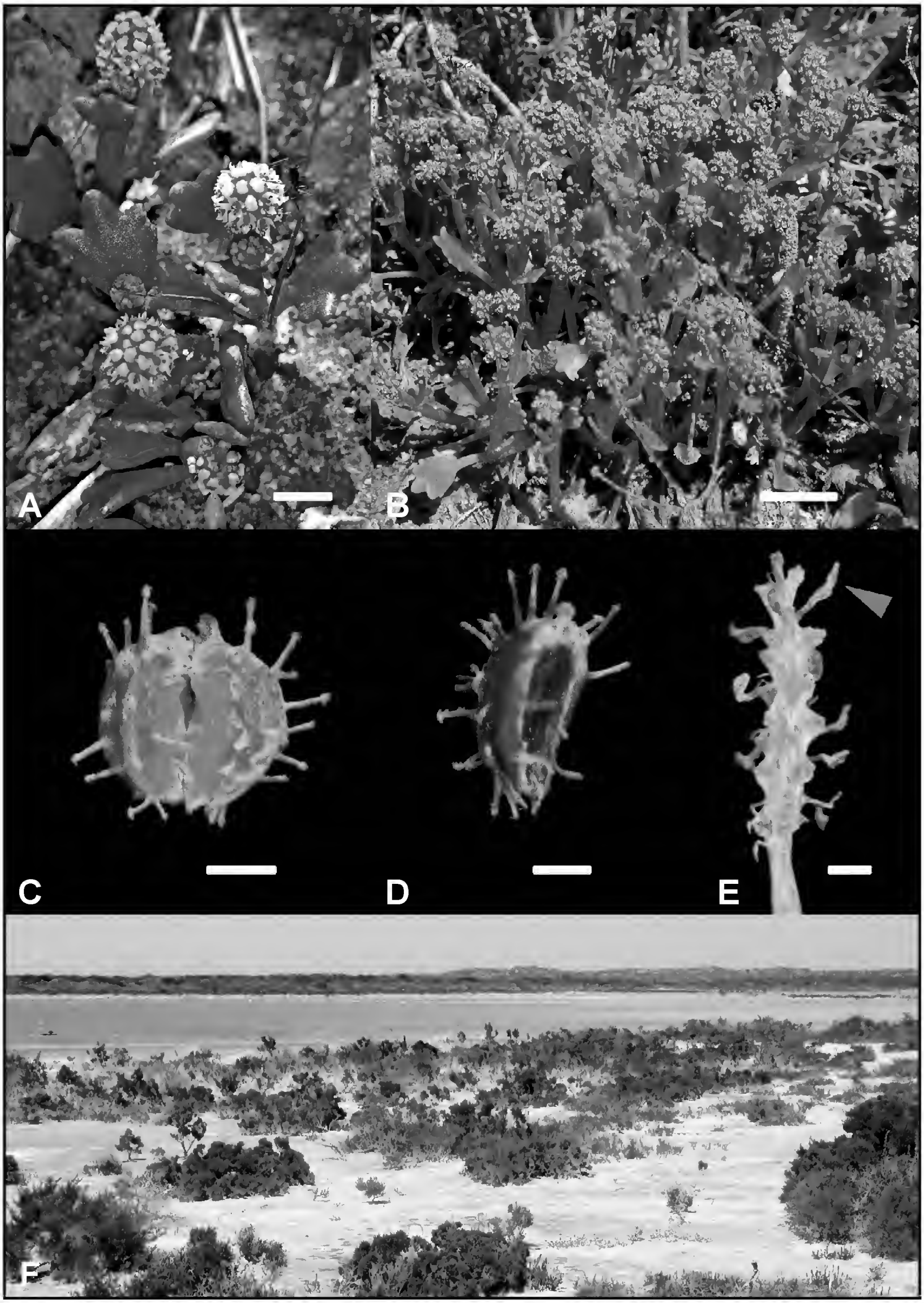

Figure 2. *Hydrocotyle glochidiata*. A – fertile plants *in situ* during early stages of anthesis; B – fertile plants *in situ* during later stages of fruit maturation; C – lateral view of a mature schizocarp prior to disarticulation of the two mericarps; D – lateral view of a single mericarp bearing glochidiate trichomes and showing internal cavity; E – peduncle and rachis of an inflorescence after full disarticulation of mericarps, showing persistent floral bracts (yellow arrowhead), reduced pedicels and a few scattered hairs along the rachis; F – typical habitat. Scale bars = 5 mm (A); 20 mm (B); 0.5 mm (C, D); 1 mm (E). Vouchers: PERTH 08029504 (A); PERTH 08029466 (B); PERTH 08728712 (C, D, E). Photographs by A. Perkins.

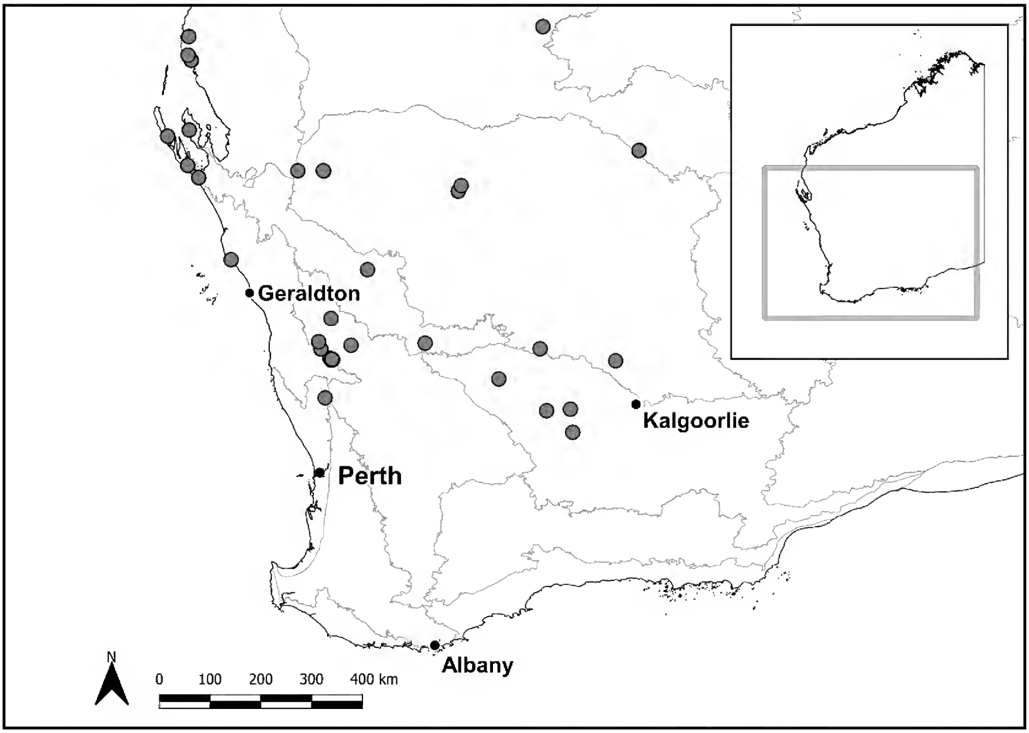

Figure 3. Distribution of *Hydrocotyle glochidiata* (●) based on selected specimens held at CANB, MEL, NSW and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2019).

Conservation status. *Hydrocotyle glochidiata* is a widely distributed species, specifically associated with saline habitats. No conservation code applies.

Etymology. The epithet is derived from the Latin *glochidiatus*, 'provided with barbs', in reference to the distinctive glochidiate hairs on the schizocarps (Figure 2C,D). The common name 'Salt-lake Pennywort' is here suggested.

Affinities. *Hydrocotyle glochidiata* is a morphologically distinct species that Domin (1908) placed in the monotypic genus *Neosciadium* Domin due to its succulent leaves and stems, leaf blades with tapering bases, flowers in dense spicate inflorescences, distinctive glochidiate trichomes on schizocarps, and mericarps that are slightly laterally flattened and broadly trapezoidal in cross-section. Many of the key morphological features that Domin considered to be diagnostic, such as succulence and simple, toothed leaves with tapering bases, are merely autapomorphies associated with the saline habitat of this distinctive species. Recent molecular phylogenetic analyses (Perkins 2019a) place this species within a clade of annual *Hydrocotyle* that have persistent floral bracts, referred to as the bracteate annuals (Figure 1).

Hydrocotyle intertexta R.Br. ex A.Rich. *Ann. Gen. Sci. Phys.* 4: 213. t. 61. fig. 28 (1820). *Type citation*: 'Elle a été rapportée de la Nouvelle-Hollande par M. R. Brown. (V.S.)'. *Type specimens*: King George III Sound [Albany, Western Australia], December 1801, *R. Brown s.n.* (*lecto*, here designated: P 00115415 image!; *isolecto*: P 00115414 image!); King George III Sound [Albany, Western Australia], December 1801, *R. Brown s.n.* (excluded *syn*: BM 000810385 image!, K 000686148 image!, K 000686149 image!, MEL 7978!).

Hydrocotyle pilifera Turcz. *Bull. Soc. Imp. Naturalistes Moscou* 22/2 (3): 26–27 (1849). *Type citation*: 'Nova Hollandia, Swan River, Drum. coll. 1839. Numerus mihi ignotus'. *Type specimens*: Swan River, Western Australia, 1839, *J. Drummond s.n.* (*lecto*, here designated: KW 001001400 image!; *isolecto*: K 000686153 image! [bottom row of plants on sheet]).

Hydrocotyle pilifera var. *glabrata* Benth. *Fl. Austral.* 3: 344 (1867). *Type citation*: 'Swan River, Drummond 1st. Coll.'. *Type specimen*: Swan River, Western Australia, *J. Drummond* (*holo*: K 000686154 image!).

[*Hydrocotyle hirta auct. non* R.Br. ex A.Rich.: G. Bentham in *Fl. Austral.* 3: 340 (1867) *pro parte*.]

Annual herbs 1.5–15 cm high, 2–25 cm wide, with 2–6 basal leaves and branched stems bearing leaves and umbellate inflorescences. *Stems* ascending to erect, pale green to reddish green, terete, glabrous or sparsely to villously covered with wiry simple hairs. *Stipules* white, ovate, 1.0–4.5 mm long, 0.8–4.0 mm wide, membranous, translucent, irregularly toothed to fimbriate along margins. *Petioles* 4–60 mm long, glabrous or sparsely to densely hairy. *Leaf blades* simple, dorsiventral, carnose, trilobed to palmatifid in juvenile leaves, palmatifid to pedate in mature leaves, 4–25 mm long, 6–30 mm wide; adaxial surface light green or reddish green, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous or sparsely covered with simple hairs. *Leaf margins* toothed; teeth mostly rounded to obtuse or occasionally acute. *Median leaf lobes* ovate to oblanceolate, 3–20 mm long, 2–12 mm wide, with 3–7 marginal teeth. *Lateral leaf lobes* 3–15 mm long, 3–20 mm wide, with 4–9 marginal teeth; leaf sinuses 20–75% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 3–16(–20)-flowered, 2–6 mm wide. *Peduncles* terete, much shorter than subtending leaf at anthesis, becoming up to half as long as the subtending leaf when in fruit, 0.2–4.5 mm long, glabrous or sparsely to villously covered with simple hairs. *Floral bracts* absent. *Pedicels* light green, subterete at anthesis, 0.1–0.2 mm long. *Flowers* all bisexual, protandrous. *Sepals* absent. *Petals* 5, white to pale cream, ovate, 0.5–0.7 mm long, 0.4–0.5 mm wide. *Filaments* pale cream, 0.4 mm long. *Anthers* creamy yellow, elliptic, 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, broadly obcordate, dorsal and lateral ribs raised in profile. *Fruiting pedicels* distinctly flattened longitudinally, 1.0–2.5 mm long, outermost pedicels basally connate, each joined by a membranous flap of tissue. *Schizocarps* bilaterally flattened, symmetrical, broadly obcordate; mericarps light green turning dark reddish brown at maturity; commissure 95% the length of mericarps. *Mericarps* 0.8–1.2 mm wide, 1.3–1.6 mm long, minutely colliculate; dorsal rib conspicuous, thickened; lateral ribs prominently thickened and raised; mericarp surface between dorsal and lateral ribs concave, with (4–)5–7(–8) prominent tubercles longitudinally arranged along the margins of both ribs, often with interconnecting transverse ridges; surface between lateral and median ribs deeply concave, glabrous or occasionally with a few obscure tubercles adjacent to lateral rib. *Carpophores* persistent, acerose, 0.7–1.0 mm long. *Fruiting styles* slender at the base, 0.5 mm long, fully reflexed. *Cotyledons* oblong to oblanceolate in the seedlings. (Figure 4)

Diagnostic features. *Hydrocotyle intertexta* can be distinguished from all other species of *Hydrocotyle* by a combination of the following characters: annual herbs with ebracteate flowers densely arranged in simple, dome-shaped umbels; pedicels subterete, becoming distinctly flattened when in fruit, outermost pedicels basally connate (joined by a membranous flap of tissue); mericarp surface between median and lateral ribs distinctly concave and glabrous; mericarp surface between dorsal and lateral ribs with prominent tubercles longitudinally arranged along the margins of both ribs (Figure 4C, D), often with interconnecting transverse ridges; carpophores persistent, acerose (Figure 4D).

Figure 4. *Hydrocotyle intertexta*. A – fertile plant *in situ* flowering and fruiting; B – portion of flowering plant showing an umbel at the early stages of anthesis and a developing infructescence; C – lateral view of a mature schizocarp; D – abaxial view of a mature infructescence showing mature schizocarps, longitudinally flattened fruiting pedicels and persistent acerose carpophores. Scale bars = 5 mm (B); 1 mm (C); 2 mm (D). Vouchers: *K.R. Thiele* 3394 (B); *M. Hislop* 1602 (C, D). Photographs by A. Perkins (A, C, D) and K. Thiele (B).

Selected specimens. WESTERN AUSTRALIA: 5 km NE of Norseman Post Office, *c*. 1 km N of Eyre Hwy, 29 Aug. 1974, *A.C. Beauglehole* 49342 (CANB, MEL, PERTH); 4.5 km SW of Illaara no. 2, Illaara Station, 12 Sep. 1988, *R.J. Cranfield* 7393 (CANB, PERTH); *c*. 2.5 km WNW of Bolgart on Bolgart West Rd, 26 Sep. 2000, *R. Davis* WW09-10 (PERTH); Hamelin Bay, 2 Oct. 1976, *Hj. Eichler* 22031 (CANB, NSW, PERTH); Totadgin Rock, *c*. 13 km SSW of Merredin, 15 Sep. 1982, *Hj. Eichler*

23010 (CANB, NSW, PERTH); Tutanning Reserve, SE of Pingelly, 21 Sep. 1974, *A.S. George* 12863 (CANB, PERTH); *c.* 8 km NE of Bungalbin Hill, Aurora Range, 25 Sep. 1995, *N. Gibson & M. Lyons* 3350 (PERTH); Dalwallinu Town Reserve towards NE corner, 16 Sep. 1999, *M. Hislop* 1602 (PERTH); 13 km ENE of Gunyidi, 2.1 km E of intersection of Noble Rd on Gunyidi Wubin Rd, S of road on E side of lake, 28 Sep. 1999, *M.N. Lyons & S.D. Lyons* 4444 (PERTH); Weld Range, on Madoonga Station, *c.* 60 km NNW of Cue, *c.* 9 km E of The Gap and 1 km E of Little Wilgie Mia, 2 Sep. 2005, *A. Markey & S. Dillon* 3201 (PERTH); Mount Willgonarinya, *c.* 72 km SSW of Balladonia Motel, Eyre Hwy, 15 Sep. 1980, *K.R. Newbey* 7394 (PERTH); Pallarup Rocks, 70 m W of outcrops, Pallarup Nature Reserve, 27 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH); roadside along Mullewa Wubin Rd, *c.* 150 m N of Wubin, 4 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH); north side of Warriedar Copper Mine Rd, along embankment of a dry creek, 4 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH); dirt track running N of Hamelin Bay, 300 m E of Hamelin Bay carpark, 19 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH); 80 m N of the carpark entrance to Wedge Lookout, along Indian Ocean Drive, 9 Oct. 2016, *A.J. Perkins* AJP-WA117 (PERTH); *c.* 2 km E of Bremer Bay town centre and bayside to the entrance to Devil Creek, 24 Oct. 2018, *A.J. Perkins* AJP-WA151 (PERTH); Mortlock Nature Reserve, 28 Sep. 2007, *K.R. Thiele* 3394 (PERTH); junction of Douglas Rd and Maders Rd, NW of Woodanilling, 16 Oct. 2012, *WA Herbarium* WAH229 (PERTH); 13 km W of Gnowangerup, 27 Sep. 1966, *P.G. Wilson* 4164 (CANB, PERTH).

SOUTH AUSTRALIA: Hambidge Flora Reserve, *c.* 3 km E of Prominent Hill, 8 Oct. 1966, *C.R. Alcock* 1129 (CANB); Hundred of Ramsay, *c.* 15 km ESE of Minlaton, *c.* 90 km W of Adelaide, 23 Aug. 1970, *B.J. Blaylock* 1521 (CANB); Gawler Ranges, *c.* 11 km W of Kolendo, *c.* 20 km WNW of Nonning, *c.* 120 km W of Port Augusta, 26 Sep. 1969, *J. Carrick* 2347 (CANB); *c.* 15 km W of Murray Bridge, Scrub SE of 'Mallee View' Homestead, 30 Sep. 1974, *J. Carrick* 3657 (CANB); Gawler Ranges, Granite Hills 5 km S of Scrubby Peak, 19 Oct. 1975, *R.J. Chinnock* 2885 (CANB); *c.* 20 km NW of Port Kenny, in scrubland E of the road to Streaky Bay, 13 Oct. 1967, *Hj. Eichler* 19473 (CANB); Gawler Range, *c.* 32 km NNE of Minnipa, hill NW of the track to Yardea, 27 Oct. 1968, *Hj. Eichler* 20479 (CANB); Gawler Ranges, Yandinga Gorge, on hill SW of well in the valley, 13 Oct. 1969, *Hj. Eichler* 20650 (CANB); Gawler Ranges, between Minnipa and Yardea, *c.* 4.5 km NE of Peterby Yards, 17 Sep. 1971, *Hj. Eichler* 21378 (CANB); Lowan Conservation Park, 10 Oct. 1984, *E.N.S. Jackson* 5553 (CANB); roadside *c.* 6 km NW of Stansbury, just S of the Minlaton-Stansbury Rd, 11 Oct. 1970, *A.E. Orchard* 2585 (CANB); Hambidge Reserve, Eyre Peninsula, NW and NNW from Prominent Hill, 8 Oct. 1966, *D.E. Symon* 4175 (CANB); Moonta Rd, Yorke Peninsula, *s. dat., J.G.O. Tepper* 112 (MEL); crown land adjacent to Pinkawillinie Recreation Park, *c.* 50 km W of Kimba, *c.* 7 km NE of Corrobinnie Hill, 5 Oct. 1981, *J.Z. Weber* 6899 (CANB).

VICTORIA: Berrook Track, 17.9 km W of Sunset Tank, 14 Oct. 1986, *G.R. Lucas & D.M. Parks s.n.* (MEL 1554657); 10 miles S of Murrayville, 1 Oct. 1968, *I. Noy-Meir* 1387 (CANB).

Phenology. This species is a winter annual, with flowering and fruiting occurring from August to December.

Distribution and habitat. *Hydrocotyle intertexta* is broadly distributed across the south-west of Western Australia and the south-eastern regions of South Australia, also extending eastward over the state border into north-western Victoria (Figure 5). This species grows mostly in sand or sandy loam soils in a variety of different vegetation types, from coastal heathlands and woodlands, to inland *Eucalyptus* and *Melaleuca* dominant woodlands, as well as arid mallee communities.

Conservation status. *Hydrocotyle intertexta* is a widely distributed and common species. No conservation code applies.

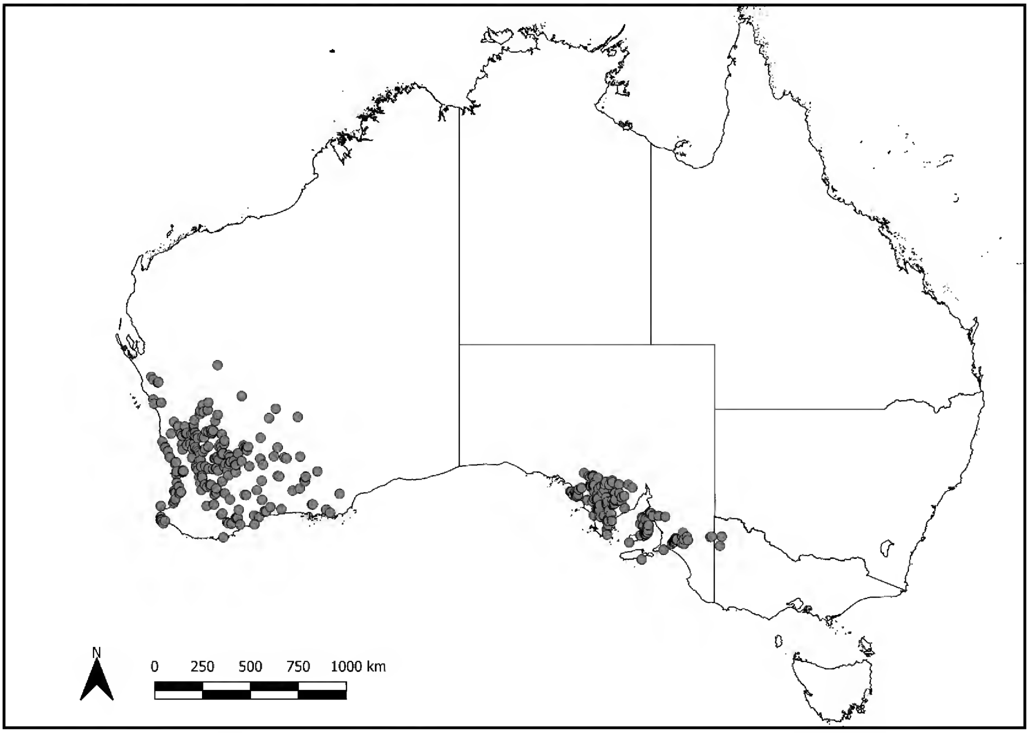

Figure 5. Distribution of *Hydrocotyle intertexta* (●) based on selected specimens held at CANB, MEL, NSW and PERTH. Map of Australia with state borders. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2019).

Etymology. The epithet is derived from the Latin *intertextus*, meaning 'interwoven', probably in reference to the prominent tubercles on the fruit which are longitudinally arranged along the margins of the lateral and dorsal ribs of the mericarps, often with interconnecting transverse ridges, making them appear interwoven (Figure 4C).

Affinities. *Hydrocotyle intertexta* is an ebracteate annual with fruiting pedicels that are distinctly flattened and joined at their base by a membranous flap of tissue, and with persistent, acerose carpophores. These morphological character traits are shared by *H. corynophora* F.Muell., *H. dimorphocarpa* A.J.Perkins, *H. muriculata* Turcz. and *H. spinulifera* (Perkins 2017a, 2018a). The relationship of *H. intertexta* with *H. dimorphocarpa*, *H. muriculata* and *H. spinulifera*, is highly supported based on phylogenetic analyses of chloroplast and nuclear DNA sequence data (Figure 1; Perkins 2019a). *Hydrocotyle intertexta* can readily be distinguished from these closely related taxa by the prominent tubercles that are longitudinally arranged along the margins of the lateral and dorsal ribs of the mericarps, often with interconnecting transverse ridges (Figure 4C).

Typification. The two sheets held in Paris (P00115414 and P00115415) are the original material viewed (in the dried state) by Achille Richard when he formulated the species description for the protologue of *H. intertexta* in 1820. They also contain annotated descriptive notes in Robert Brown's hand that correspond to the protologue. The specimen P00115415 is the better quality of the two syntypes at Paris, with persistent carpophores clearly visible and is, therefore, designated as lectotype. Three remaining possible syntypes lodged at BM, K and MEL, bear whole plants that are more than twice the size of those mounted on the P sheets, and represent a second, distinct taxonomic entity (corresponding to *H. perplexa*). Bentham (1867) viewed the BM specimen and concluded that *H. intertexta* was just a

variety of *H. hirta* as it lacked carpophores, which is a diagnostic character cited in the protologue (Richard 1820). Examination of images of the BM, K and MEL material indicated that these specimens do possess carpophores (Wakefield 1951; this study), but they are filiform and fragile, often prone to breaking off in the process of pressing, drying and mounting of the specimens. Bentham's misapplication of the BM specimen to *H. hirta* was understandable since he was unaware that the syntypes Richard viewed (held at P) were part of a mixed gathering made by Brown.

Consequently, in 1845 Turczaninow described *H. pilifera* based on collections of this taxon made by Drummond in 1839. The herbarium voucher KW 001001400 is selected as an appropriate lectotype for *H. pilifera* as it matches the taxonomic description and conforms to the published protologue (Turczaninow 1849).

Hydrocotyle perplexa A.J.Perkins, *sp. nov.*

Type: south side of Mandalay Beach Road, 2.2 km from South Western Highway, Western Australia, 30 October 2018, *A.J. Perkins* AJP-WA 159 (*holo*: PERTH 09078185; *iso*: AD, BRI, MEL).

Hydrocotyle hispidula var. *tenella* Benth., *Fl. Austral.* 3: 343 (1867). *Type citation*: 'Warren river, Herb. F. Mueller'. *Type specimens*: 'Warren River' [Western Australia], *s. dat.*, *F. von Mueller s.n.* (*lecto*, here designated: K 000686147 image!; *isolecto*: MEL 8275!).

[*Hydrocotyle hirta auct. non* R.Br. ex A.Rich.: G. Bentham in *Fl. Austral.* 3: 339–340 (1867), *pro parte.*]

[*Hydrocotyle scutellifera auct. non* Benth.: A.J. Perkins in *Mol. Phylogen. Evol.* 134: 129–141 (2019).]

Hydrocotyle puberula H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 1 April 2019].

Hydrocotyle sp. Puberula (H.Eichler 22058), *Australian Plant Census*, https://id.biodiversity.org.au/name/apni/241655 [accessed 1 April 2019].

Annual herbs 1–5 cm high, 10–80 cm wide, with 2–8 basal leaves and branched stems bearing leaves and umbellate inflorescences. *Stems* prostrate to decumbent, pale green to yellowish green or reddish green, terete, glabrous, occasionally producing roots at nodes. *Stipules* white, elliptic to broadly ovate, 0.8–3.0 mm long, 0.8–3.0 mm wide, membranous, translucent, irregularly toothed to fimbriate along margins. *Petioles* 2–50 mm long, glabrous. *Leaf blades* predominantly simple rarely compound, dorsiventral, carnose, mostly trilobed to palmatifid, rarely trifoliolate in mature leaves, 4–16 mm long, 4–20 mm wide, cordate at the base, glabrous; adaxial surface light green; abaxial surface slightly paler in colour than adaxial. *Leaf margins* toothed; teeth mostly rounded to obtuse or occasionally acute. Median leaf lobes oblanceolate, 3–12 mm long, 2–11 mm wide, with 3–5 marginal teeth. Lateral leaf lobes 2–11 mm long, 3–14 mm wide, with 2–8 marginal teeth; leaf sinuses 15–50% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 6–20-flowered, 2–4 mm wide. *Peduncles* terete, shorter than subtending leaf at anthesis, becoming distinctly longer than subtending leaf when in fruit, 3–35 mm long, glabrous. *Floral bracts* lanceolate, 0.4–1.0 mm long, margins entire to occasionally toothed. *Pedicels* light green, subterete, longitudinally flattened, 0.1–0.3 mm long. *Flowers* all bisexual, protandrous. *Sepals* absent. *Petals* 5, white to pale cream, ovate, 0.4–0.5 mm long, 0.3–0.4 mm wide. *Filaments* white, *c.* 0.3 mm long. *Anthers* creamy yellow to crimson, elliptic, *c.* 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, elliptic. *Fruiting pedicels*

0.4–1.0 mm long, longitudinally flattened. *Schizocarps* bilaterally flattened, symmetrical, elliptic; initially light green, often fading to pale cream before turning light brown at maturity; commissure 90–95% the length of mericarps. *Mericarps* reniform, glabrous or papillate, 1.0–1.2 mm long, 0.5–0.6 mm wide; bases cordate, apices subcordate to cordate; dorsal and lateral ribs conspicuous, acute; median ribs inconspicuous; surface between dorsal and lateral ribs flat to slightly concave; surface between lateral and median ribs slightly concave. *Carpophores* persistent but fragile, filiform, 0.4–0.6 mm long. *Fruiting styles* distinctly thicker at the base, *c.* 0.3 mm long, fully reflexed. *Cotyledons* elliptic to lanceolate in the seedlings. (Figure 6)

Diagnostic features. *Hydrocotyle perplexa* can be distinguished from allied species by a combination of the following characters: glabrous annuals herbs, flowers with white to pale cream petals, fruiting peduncles longer than opposing leaves, reniform mericarps with glabrous or papillate surfaces, persistent floral bracts (Figure 6B) of similar length to fruiting pedicels (0.4–1.0 mm long), reflexed fruiting styles, persistent carpophores filiform and fragile (Figure 6C).

Selected specimens examined. WESTERN AUSTRALIA: Windy Harbour, 2 Dec. 1986, *A.R. Annels* 1896 (PERTH); Mays Rd, 4.5 km due N of Manjimup, 20 Nov. 1994, *A.R. Annels* 4979 (PERTH); coastal foreshore near Ledge Isle, 13 Dec. 1983, *R.J. Cranfield* 4887 (PERTH); 20 miles S of Gum Nut Rd, Northcliffe, 2 Dec. 1999, *R.J. Cranfield* 14510 (PERTH); Mount Chudalup, at base, 3 Oct. 1976, *Hj. Eichler* 22056 (CANB, PERTH); Mount Chudalup, at base, 3 Oct. 1976, *Hj. Eichler* 22058 (CANB, PERTH); Mount Chudalup, 22 Sep. 1982, *Hj. Eichler* 23049 (CANB, PERTH); 0.7 km from Bussell Hwy on road to Yalgorup beach, 25 Sep. 1985, *Hj. Eichler* 23697 (CANB, PERTH); *c.* 1 km S of junction of Thomas Rd and Johnson Rd, E of Medina, 18 Sep. 1977, *A.S. George* 14906 (CANB, PERTH); Lake William, West Cape Howe, 30 km W of Albany, 9 Nov. 1987, *G.J. Keighery* 9808 (PERTH); Ellis Rd, Yalgorup National Park, 14 Oct. 1996, *G.J. Keighery* 14555 (PERTH); central firebreak, above N flat, Gingilup Swamps Nature Reserve, 3 Dec. 2002, *G.J. Keighery, N. Gibson & W. Muir* 7227 (PERTH); granite outcrop 100 m N of Mount Chudalup peak, D'Entrecasteaux National Park, 16 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH); granite outcrop 400 m inside West Cape Howe National Park entrance heading south along Hortons Rd South, 18 Oct. 2007, *A.J. Perkins s.n.* (PERTH, NSW); western shoreline of Lake Preston *c.* 350 m E of Preston Beach township, 20 Nov. 2016, *A.J. Perkins* AJP-WA 134 (PERTH); Owingup Nature Reserve, Parryville, W side of Boat Harbour Rd 1.6 km from South Coast Hwy, 20 Nov. 2017, *A.J. Perkins* AJP-WA 146 (AD, CANB, MEL, NSW, PERTH); south side of Ficifolia Rd, 240 m W of Peaceful Bay Rd, Walpole-Nornalup National Park, 21 Nov. 2017, *A.J. Perkins* AJP-WA 147 (MEL, NSW, PERTH); 800 m W of Windy Harbour Rd and *c.* 3.5 km SW of Mount Chudalup, 22 Nov. 2015, *A.J. Perkins & R. Davis* AJP-WA 111 (PERTH); 800 m W of Windy Harbour Rd and *c.* 3.5 km SW of Mount Chudalup, 22 Nov. 2015, *A.J. Perkins & R. Davis* AJP-WA 112 (PERTH); south-west Porongurup Range, western slopes of Nancy's Peak, 29 Sep. 1966, *P.G. Wilson* 4251 (CANB, PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from late August to December.

Distribution and habitat. *Hydrocotyle perplexa* is broadly distributed in the south-west of Western Australia, from coastal areas of Perth in the north, to Cape Leeuwin in the south-west, through to the Porongurup Range and Albany in the east (Figure 7). Plants often grow in moist, sheltered positions in sandy humic soil associated with coastal *Agonis* woodlands, or *Melaleuca* woodlands along freshwater swamps, creeks or lakes, or on moist granite outcropping along the coast and in near-coastal areas (Figure 6D).

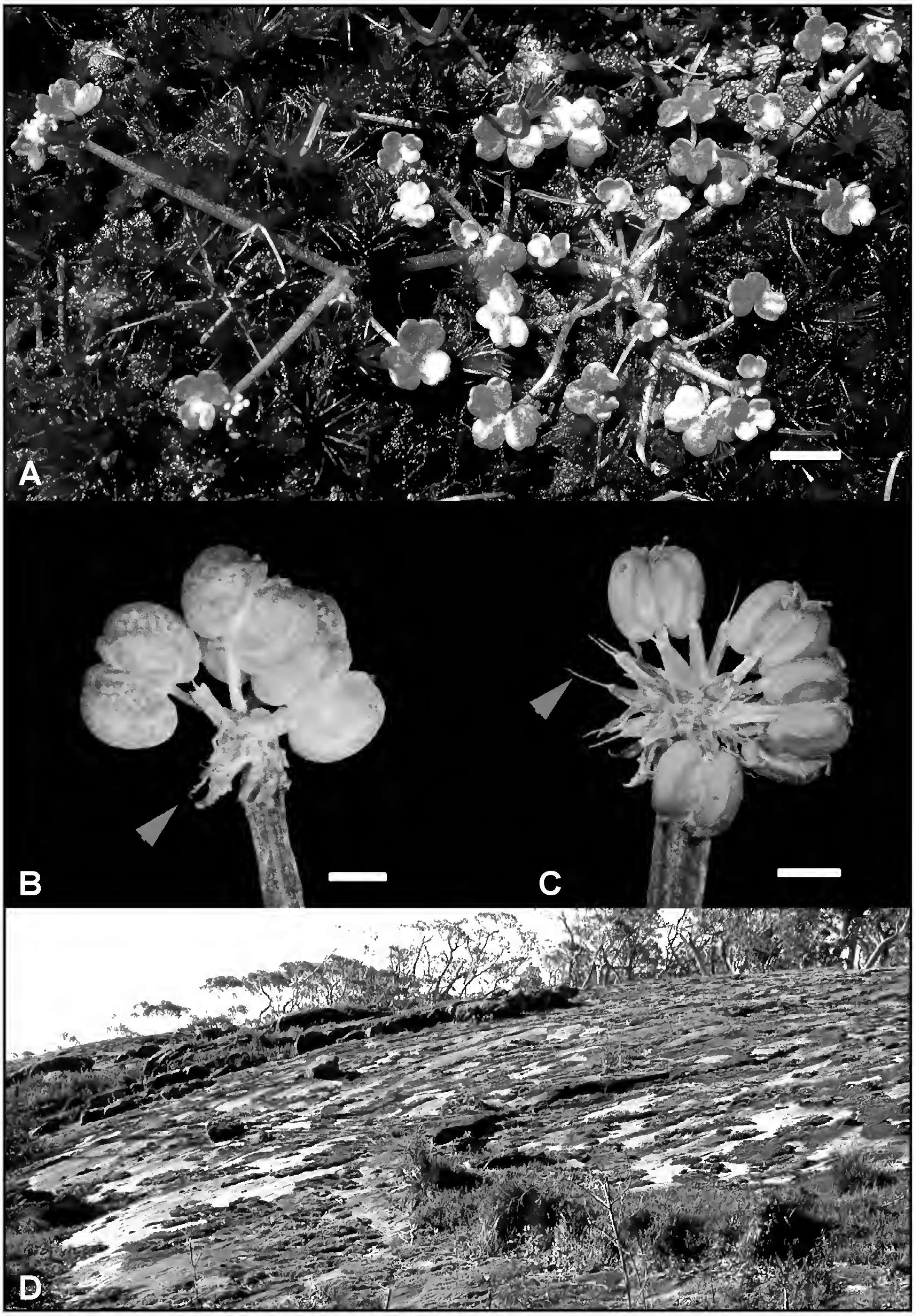

Figure 6. *Hydrocotyle perplexa*. A – fertile plants in situ during early stages of anthesis; B – infructescence showing floral bracts (yellow arrowhead) subtending pedicels and mature schizocarps with papillate surfaces; C – infructescence showing flattened pedicels with persistent filiform carpophores (red arrowhead) and mature schizocarps with glabrous surfaces; D – typical habitat. Scale bars = 10 mm (A); 1 mm (B, C). Vouchers: PERTH 08048622 (A); PERTH 04055950 (B); PERTH 06527744 (C). Photographs by A. Perkins.

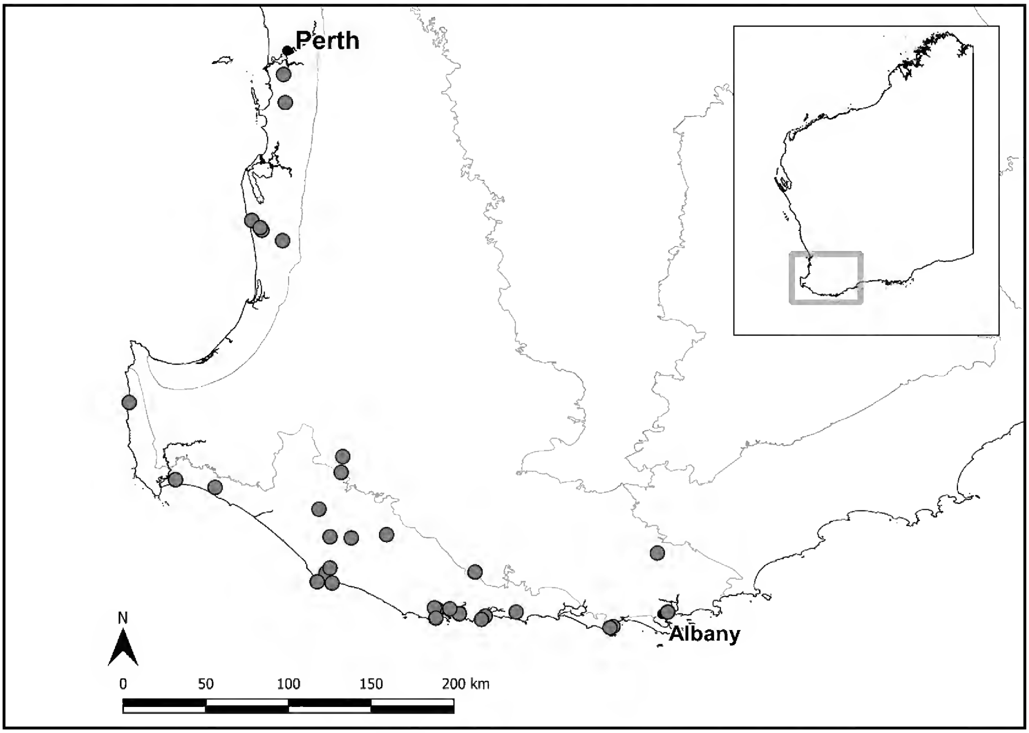

Figure 7. Distribution of *Hydrocotyle perplexa* (●) based on selected specimens held at CANB, MEL, NSW and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2019).

Conservation status. *Hydrocotyle perplexa* is a widely distributed and common species. No conservation code applies.

Etymology. The epithet is derived from the Latin *perplexus*, meaning 'obscure, confused, intricate'. It firstly refers to the complicated and confused taxonomic history of this taxon based on the misapplications of obscure, polymorphic fruit character traits formerly used to circumscribe annual taxa in Western Australia. This epithet refers also to the intricate, entanglement of stems in large individual plants and to plants often found growing in dense colonies. The common name 'Intricate Pennywort' is here suggested.

Affinities. Recent molecular phylogenetic reconstructions (Perkins 2019a) place *H. perplexa* within a clade of bracteate annuals and in a sister relationship with *H. scutellifera* and *H. lemnoides* (Figure 1). *Hydrocotyle perplexa* is morphologically most similar to *H. scutellifera s. str.* and can be readily distinguished from it by having white to pale cream petals (crimson in *H. scutellifera*), elliptic schizocarps (orbicular in *H. scutellifera*), shallowly concave mericarp surfaces (scutellate mericarp surfaces in *H. scutellifera*), floral bracts similar in length to fruiting pedicels (distinctly shorter for *H. scutellifera*), reflexed fruiting styles (erect to ascending fruiting styles in *H. scutellifera*) and persistent carpophores filiform and fragile (carpophores not persistent in *H. scutellifera*).

Typification. The herbarium voucher K 000686147 is selected as an appropriate lectotype of *H. hispidula* var. *tenella* as it is marked as seen by Bentham for his *Flora Australiensis* treatment (1867) and has flowering umbels and mature fruit that conform to his taxonomic description.

Notes. As discussed in detail in the first subsection of this taxonomy account, *H. perplexa* is described as a new species as a result of a historic series of misapplied names and the lack of an available epithet for this taxon.

Hydrocotyle scutellifera Benth., *Fl. Austral.* 3: 343 (1867). *Type citation*: '*Swan River,* Drummond 1st Coll. and 2nd Coll. n. 4'. *Type specimens*: Swan River, [Western Australia], 1839, *J. Drummond* [1st coll.] *s.n.* (*lecto*, here designated: K 000686144 image!); Swan River, [Western Australia], 1843, *J. Drummond*, 2nd Coll. n. 4. (*syn*: BM 000810391 image!, G 00366924 image!, G 00366946 image!, K 000686143 image! [left hand specimen on the sheet accompanied with illustrations of a stipule and schizocarp], K 000686145 image!, LE 00015634 image!, MEL 7855!, P 00115426 image!, P 00115427 image!).

Hydrocotyle blepharocarpa F.Muell., *S. Sci. Rec.* 3: 175 (1883). *Type*: 'Upper Swan River' [Western Australia], 1883, *Miss Julia Sewell s.n.* (*holo*: MEL 7788!; *iso*: MEL 7789!).

Annual herbs 1–3 cm high, 5–30 cm wide, with 3–6 basal leaves and branched stems bearing leaves and umbellate inflorescences. *Stems* prostrate to ascending, pale green to yellowish green or reddish green, terete, glabrous. *Stipules* white, lanceolate to broadly ovate, 1.0–2.5 mm long, 0.5–1.2 mm wide, membranous, translucent, irregularly toothed to fimbriate along margins. *Petioles* 4–40 mm long, glabrous. *Leaf blades* simple, dorsiventral, carnose, trilobed to palmatifid, 4–15 mm long, 4–20 mm wide, cordate at the base, glabrous; adaxial surface light green; abaxial surface slightly paler in colour than adaxial. *Leaf margins* toothed; teeth mostly rounded to obtuse. *Median leaf lobes* oblanceolate, 3–12 mm long, 3–9 mm wide, with 3–5 marginal teeth. *Lateral leaf lobes* 2–11 mm long, 3–11 mm wide, with 2–8 marginal teeth; leaf sinuses 10–40% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 6–18-flowered, 2–4 mm wide. *Peduncles* terete, shorter than subtending leaf at anthesis, becoming distinctly longer than subtending leaf when in fruit, 2–45 mm long, glabrous. *Floral bracts* linear to linear lanceolate, margins entire to sparsely ciliate, 0.4–0.6 mm long. *Pedicels* light green, subterete, longitudinally flattened, 0.1–0.3 mm long. *Flowers* all bisexual, protandrous. *Sepals* absent. *Petals* 5, pale to dark crimson, ovate, 0.4–0.5 mm long, 0.3–0.4 mm wide. *Filaments* white, 0.2–0.3 mm long. *Anthers* creamy yellow, elliptic, *c.* 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular. *Fruiting pedicels* 0.5–1.2 mm long, innermost pedicels distinctly longer than their subtending floral bracts and the peripheral whorl of pedicels. *Schizocarps* bilaterally flattened, symmetrical, orbicular; bases cordate; mericarps light green turning reddish brown at maturity; commissure 90–95% the length of mericarps. *Mericarps* 0.8–1.0 mm long, 0.6–0.8 mm wide, glabrous or fringed with hairs; dorsal and lateral ribs conspicuous, acute; median ribs raised and swollen at surface; surface between dorsal and lateral ribs concave, glabrous or with bristly hairs on raised surface adjacent to lateral ribs; surface between lateral and median ribs glabrous, slightly concave, scutellate. *Carpophores* absent. *Fruiting styles* slender, *c.* 0.2 mm long, erect to ascending. *Cotyledons* oblanceolate in the seedlings. (Figure 8)

Diagnostic features. *Hydrocotyle scutellifera* can be distinguished from allied species by a combination of the following characters: annual herbs with glabrous stems, leaves, peduncles and pedicels; flowers with crimson petals; orbicular schizocarps with variably hairy outer margins of the lateral ribs (from dense to sparsely hairy or glabrous) and erect to ascending fruiting styles; mericarps with (semi-circular) scutellate lateral surfaces arising from the prominently raised lateral and median ribs; innermost fruiting pedicels (0.5–1.2 mm long) distinctly longer than their subtending floral bracts (0.4–0.6 mm long) and the peripheral whorl of pedicels; and the absence of persistent carpophores (Figure 8).

Figure 8. *Hydrocotyle scutellifera*. A – fertile plants *in situ* during later stages of fruiting, infructescences with glabrous fruit indicated with the red arrowheads; B – infructescence showing mature schizocarps with densely bristly outer margins; C – infructescences following disarticulation of mature mericarps showing fruiting pedicels distinctly longer than subtending floral bracts (yellow arrowhead). Scale bars = 5 mm (A); 2 mm (B, C). Vouchers: PERTH 09078169 (A); PERTH 08502579 (B); PERTH 08840784 (C). Photographs by A. Perkins.

Selected specimens examined. WESTERN AUSTRALIA: Yanchep area, 29 Aug. 1965, *A.C. Beauglehole* 12382 (AD, MEL, PERTH); track to Point Nuyts, Nornalup National Park, 2 Oct. 1967, *R.O. Belcher* 329 (MEL); Grevillea Tower rock, Winnejup forest block, N of Kingston Rd along North Boundary Rd, left hand side 0.75 km, 8 Nov. 2005, *R.J Cranfield* 21867 (PERTH); east side of Lake Timperley, Rottnest Island, 4 Oct. 2000, *J. Dodd* 794A (PERTH); at base of Mount Chudalup, 3 Oct. 1976, *Hj. Eichler* 22057 (AD, CANB, NSW, PERTH); Angwin Peak, Porongurup Ranges, 5 Oct. 1976, *Hj. Eichler* 22088A (CANB, MEL, PERTH); Old Coast Rd, N of Bunbury, 23 Sep. 1972, *A.S. George* 11627 (CANB, PERTH); *c.* 1 km S of junction of Thomas Rd and Johnson Rd, E of Medina, 18 Sep. 1977, *A.S. George* 14908 (CANB, PERTH); Yeagarup Dunes Rd, *c.* 2.5 km by road from coast, 29 Oct. 1990, *N. Gibson & M. Lyons* 983 (PERTH); rifle range (Reserve 22459), SSE of Port Denison, 29 Aug. 1991, *E.A Griffin* 6409 (PERTH); Lake Muir, *s. dat*., *T. Muir s.n.* (MEL 0008286A); south-eastern slope of Devils Slide, Porongurup Range, 29 Sep. 1966, *T.B. Muir* 3945 (MEL); summit of Castle Rock, Porongurup Range, 29 Sep. 1966, *T.B. Muir* 3960 (MEL); Porongurup National Park, along Scenic Drive below Angwin Peak, 20 Sep. 1983, *R. Ornduff* 9326 (PERTH); 200 m W of Lake Unicup, 25 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH, SYD); edge of large granite outcrop along Park Rd and below Angwin Peak, Porongurup National Park, 15 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH, SYD); large granite outcrop on N side of South Western Hwy, Shannon National Park, *c.* 1.3 km S of Middleton Rd, 16 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 8048673, SYD); 1.7 km N of Point D'Entrecasteaux, 30 Oct. 2016, *A.J. Perkins* AJP-WA131 (PERTH); south side of Mandalay Beach Rd, 400 m from Mandalay Beach carpark, 30 Oct. 2018, *A.J. Perkins* AJP-WA160 (BRI, MEL, PERTH); south side of Mandalay Beach Rd, 3 km from Mandalay Beach carpark, 30 Oct. 2018, *A.J. Perkins* AJP-WA161 (MEL, PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from August to November.

Distribution and habitat. *Hydrocotyle scutellifera* is broadly distributed in south-western Western Australia, from Dongara in the north, to Cape Leeuwin in the south-west, through to the Porongurup Range and Albany in the east (Figure 9). Plants often grow in moist, sheltered positions amongst coastal sand-dunes and limestone, or on moist granite outcropping along the coast and in near-coastal areas. Populations with both glabrous and bristly fruits are widespread and are known to occur in the Perth region, as well as the Porongurup Range, Lake Muir and near Mandalay Beach.

Conservation status. *Hydrocotyle scutellifera* is a widely distributed and common species. No conservation code applies.

Etymology. The epithet is derived from the Latin *scutella*, 'a small shield', and *fero*, 'to bear', in reference to the lateral surfaces of the fruit bearing a 'little shield' on both sides of each mericarp (Figure 8A,B). The prominently raised lateral and median ribs, with the semi-circular concave surface between them, give each mericarp their characteristic shield-like appearance. The common name 'Western Shield Pennywort' is here suggested.

Affinities. Recent molecular phylogenetic analyses place *H. scutellifera s. str.* (*syn. H. blepharocarpa*) within a clade of annual *Hydrocotyle* that have persistent floral bracts, referred to as the bracteate annuals (Figure 1). *Hydrocotyle scutellifera* is sister to the freshwater aquatic species, *H. lemnoides* in all phylogenetic reconstructions (Figure 1). Both of these species in turn form a sister relationship with *H. perplexa*. The re-circumscribed *H. scutellifera* is morphologically most similar to *H. perplexa* and can be readily distinguished from it by having crimson petals (white in *H. perplexa*), orbicular

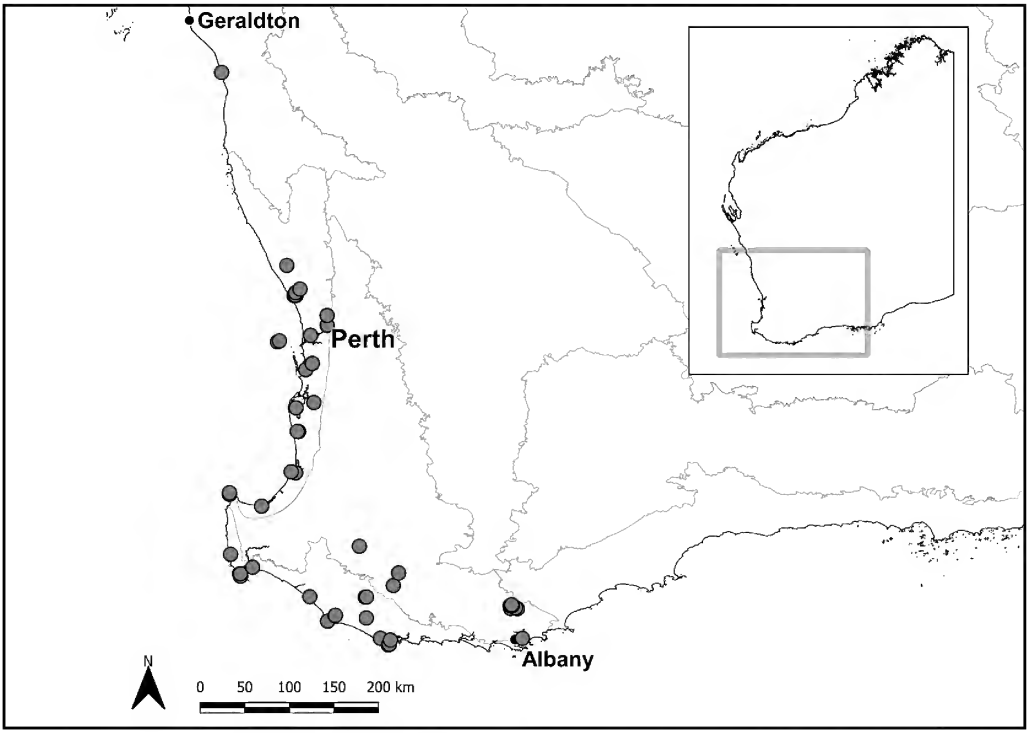

Figure 9. Distribution of *Hydrocotyle scutellifera* (●) based on selected specimens held at CANB, MEL, NSW and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2019).

schizocarps (elliptic in *H. perplexa*), scutellate mericarp surfaces (shallowly concave mericarp surfaces in *H. perplexa*), floral bracts distinctly shorter than fruiting pedicels (similar in length for *H. perplexa*), erect to ascending fruiting styles (reflexed fruiting styles in *H. perplexa*), carpophores not persistent (carpophores persistent but fragile in *H. perplexa*).

Typification. In the protologue for *H. scutellifera* (1867), Bentham cites two collections, the '1st Coll. and 2nd Coll. n. 4' both made by James Drummond. The '1st collection' consists of a single herbarium sheet held at Kew (K 000686144) with two plants, one labelled 'Swan River. Drummond, 1839' and the other stamped with 'Herbarium Benthamianum 1854'. The specimens on this sheet were gathered by Drummond during the later stages of flowering and fruiting, as well as having numerous infructescences in which mature mericarps have disarticulated from their pedicels. The presence of diagnostic features – such as the scutellate (lateral) surface morphology of the mericarps, the innermost fruiting pedicels being distinctly longer than their subtending floral bracts and the peripheral whorl of pedicels, along with the absence of persistent carpophores – make this sheet most suitable as the lectotype (designated herein). Drummond's '2nd Collection, n. 4' was made in 1843 according to annotations on the nine duplicate sheets located at BM, G, K, LE, MEL and P. The specimens in this gathering are in the early stages of flowering and fruit development, with no fully matured infructescences visible on any of the duplicate specimens. Two paralectotypes each have a single, near-mature infructescence (G 00366946 and K 000686143). The lack of mature infructescences with their characteristic features of fruiting pedicels, particularly with the herbarium sheet held at MEL, contributed to Ferdinand von Mueller's failure to recognise the affiliation between the (glabrous) scutellate fruit of *H. scutellifera* and the bristly (scutellate) fruit variant he later described as *H. blepharocarpa* in 1883 (Mueller 1883).

Notes. The polymorphic fruits of *H. scutellifera* and *H. blepharocarpa*, particularly the glabrous-fruited morphotypes, have historically caused confusion when identifying these species. The syntypes of each species are morphologically indistinguishable, except in the ornamentation of mericarp surfaces, and should be considered conspecific. *Hydrocotyle scutellifera* (Bentham 1867) has priority, thus *H. blepharocarpa* (Mueller 1883) must be placed into synonymy. Perkins (2019a) did not recover any internal structure to his *H. scutellifera* (syn. = *H. blepharocarpa*) clade, so no intraspecific taxa can be recognised at this time.

The recircumscription of *H. scutellifera* (above) makes it apparent that Perkins (2019a) misapplied the name *H. scutellifera* to five samples in his analysis. Those samples are now identified as *H. perplexa*.

Hydrocotyle tetragonocarpa Bunge in Lehm., *Pl. Preiss*. 1: 284 (1845). *Type citation*: 'In arenosis conchyliosis humidis prope lacum insulae Rotenest, 21. Aug. 1839 - Herb. Preiss. No. 2085'. *Type specimens*: Rottnest Island, Western Australia, 21 August 1839, *L. Preiss* 2085 (*lecto*, here designated: MEL 8187!; *isolecto*: FI 014716 image!, G 00366947 image!, HBG 517857 image!, K 000686158 image!, LD 1224030 image!, LE 00015635 image!, LE 00015636 image!, M 0172687 image!, MEL 8183!, P 00115433 image!, P 00115434 image!).

Hydrocotyle sp. Hamelinensis (G.J. Keighery s.n. PERTH 02391325), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 23 November 2018].

Annual herbs 1–4 cm high, 10–50 cm wide, with 3–8 basal leaves and branched stems bearing leaves and umbellate inflorescences. *Stems* prostrate to decumbent, pale green to yellowish green or reddish green, terete, glabrous or occasionally covered with scattered wiry hairs. *Stipules* white, elliptic to broadly ovate, 1.5–3.0 mm long, 1.0–2.5 mm wide, membranous, translucent, irregularly toothed to fimbriate along margins. *Petioles* 2–30(–50) mm long, glabrous or sometimes covered with scattered wiry hairs. *Leaf blades* simple, dorsiventral, carnose, palmatifid to occasionally trilobed in mature leaves, 4–18 mm long, 5–20 mm wide, cordate at the base, glabrous; adaxial surface light green; abaxial surface slightly paler in colour than adaxial. *Leaf margins* toothed; teeth mostly rounded to obtuse or occasionally acute. *Median leaf lobes* oblanceolate, 4–12 mm long, 3–7 mm wide, with 3–5 marginal teeth. *Lateral leaf lobes* 4–12 mm long, 4–14 mm wide, with 2–8 marginal teeth; leaf sinuses 15–50% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, andromonoecious, anthesis centripetal, 6–16-flowered, 2–4 mm wide. *Peduncles* terete, shorter than subtending petioles at anthesis, becoming longer than subtending petioles when in fruit, 2–20(–30) mm long, glabrous or sometimes covered with scattered wiry hairs. *Floral bracts* ovate to lanceolate, 0.3–0.5 mm long, margins entire or irregularly toothed. *Pedicels* light green, subterete, 0.3–0.5 mm long. *Male flowers* peripheral in the umbels, with ovaries not developing into fertile schizocarps. *Bisexual flowers* protandrous. *Sepals* absent. *Petals* 5, white to light cream with light pink to crimson on the adaxial surface towards the apex, ovate, 0.6–0.8 mm long, 0.4–0.6 mm. *Filaments* light cream, 0.3–0.4 mm long. *Anthers* creamy yellow or occasionally crimson, elliptic, *c*. 0.3 mm long. *Ovaries* pale green at anthesis, ovate to elliptic. *Fruiting pedicels* 0.3–0.8 mm long. *Schizocarps* symmetrical, brown to creamy brown at maturity, heterocarpic, developing into one of two morphotypes, either wingless (four-cornered) or prominently winged, glabrous, at maturity disarticulating entire from the pedicel as the mericarps remained joined to the carpophore and do not separate from each other; dorsal and median ribs conspicuously raised, obtuse; lateral ribs inconspicuous. *Wingless schizocarps* elliptic to narrowly ovate, bases and apices rounded to obtuse, 0.8–1.3 mm long, 0.7–1.2 mm wide; surface between dorsal and lateral ribs convex with a raised, thickened longitudinal ridge between the ribs; surface between lateral and median ribs convex with a raised, thickened longitudinal ridge between the ribs; commissure 100% the length of mericarps. *Winged schizocarps* orbicular to broadly obcordate,

bases rounded to truncate, apices prominently cordate, 2.4–4.0 mm long, 2.5–4.5 mm wide; surface between dorsal and lateral ribs laterally flattened; surface between lateral and median ribs convex; commissure 80–95% the length of the mericarps. *Carpophores* not persistent. *Fruiting styles* slender at the base, 0.3–0.8 mm long, distinctly incurved. *Cotyledons* oblanceolate in the seedlings. (Figure 10)

Diagnostic features. *Hydrocotyle tetragonocarpa* can be distinguished from allied annual *Hydrocotyle* species, by a combination of the following characters: flowers in simple umbels subtended by persistent bracts, umbels andromonoecious, with male flowers peripheral to the bisexual flowers (Figure 10B), heterocarpic fruit, with or without wings (Figure 10A–C), mericarps within each schizocarp that do not separate from each other after reaching maturity, and erect fruiting styles with incurved apices (Figure 10B,C).

Selected specimens examined. WESTERN AUSTRALIA: Cape Leeuwin, S of Augusta, 7 Sep. 1965, *A.C. Beauglehole* ACB 12493 (CANB, MEL, PERTH); Fish Creek, 21 Sep. 2008, *R.J. Cranfield* 23256 (PERTH); east side of Lake Timperley, Rottnest Island, 4 Oct. 2000, *J. Dodd* 794B (PERTH); Hamelin Bay, 0.6 km E of the end of the road to the jetty, 17 Sep. 1982, *Hj. Eichler* 23020 (CANB, NSW, PERTH); western side of the Augusta-Hamelin Bay Rd, *c.* 0.4 km S of the turnoff to Cosy Corner, 18 Sep. 1982, *Hj. Eichler* 23026 (CANB, NSW, PERTH); lookout between Hamelin Bay and Boranup, 27 Sep. 1985, *Hj. Eichler* 23737 (CANB, MEL, PERTH); Seal Rocks area S of Tim's Thicket Rd, Yalgorup National Park, 19 Oct. 2003, *P. Foreman* 403 (PERTH); Ledge Bay, E of Albany, 1 Oct. 1971, *A.S. George* 11095 (CANB, PERTH); *c.* 1.5 miles along William Bay Rd from Highway 1, W of Denmark, 2 Oct. 1971, *A.S. George* 11111 (CANB, PERTH); William Bay National Park, firebreak on W boundary, 25 Sep. 1994, *B.G. Hammersley* 1158 (PERTH); *c.*1.5 km N of Seabird along rough track, 9 Sep. 2001, *M. Hislop* 2305 (PERTH); 2 km N of Yallingup, Cape Naturaliste, 1 Oct. 1989, *G.J. Keighery s.n.* (PERTH); 20 km E of Augusta, 1 Nov. 2008, *M. Maier* MM 801 (PERTH); *c.* 300 m E of Hamelin Bay carpark, Leeuwin Naturaliste National Park, 19 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 08048517, SYD); southern headland above Shelley Cove, 1 km east of Cape Naturaliste Lighthouse, 18 Oct. 2011, *A.J. Perkins s.n.* (NSW 888120, SYD); Jurien coastal lakes N of Leeman, 0.8 km E of Indian Ocean Drive on S side of Coolimba-Eneabba Rd, 9 Oct. 2016, *A.J. Perkins* AJP-WA 118 (PERTH); Lake Thetis, Cervantes. SW side of the lake, 9 Oct. 2016, *A.J. Perkins* AJP-WA 124 (PERTH); south side of Mandalay Beach Rd, 2.2 km from South Western Hwy, 30 Oct. 2018, *A.J. Perkins* AJP-WA157 (AD, CANB, HO, MEL, NSW, PERTH); south of Lake Serpentine, Rottnest Island, 6 Sep. 1999, *E. Rippey* 118 (PERTH); 22 km E of Augusta, 1 Nov. 2008, *R. Warner & P. Hoffman* RW 067 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from late August to December.

Distribution and habitat. *Hydrocotyle tetragonocarpa* is distributed in coastal areas and nearby offshore islands in south-west Western Australia, from Leeman in the north, to Cape Leeuwin in the south-west and eastward to the Albany region (Figure 11). This annual species grows in damp, sandy calcareous soils associated with coastal sand dunes, limestone outcroppings and gypsum lakes (Figure 10D). Populations with both fruit morphs present are known to occur on Rottnest Island, Hamelin Bay, Foul Bay, Bunker Bay and areas around Augusta.

Conservation status. *Hydrocotyle tetragonocarpa* is a widely distributed and common species in coastal areas. No conservation code applies.

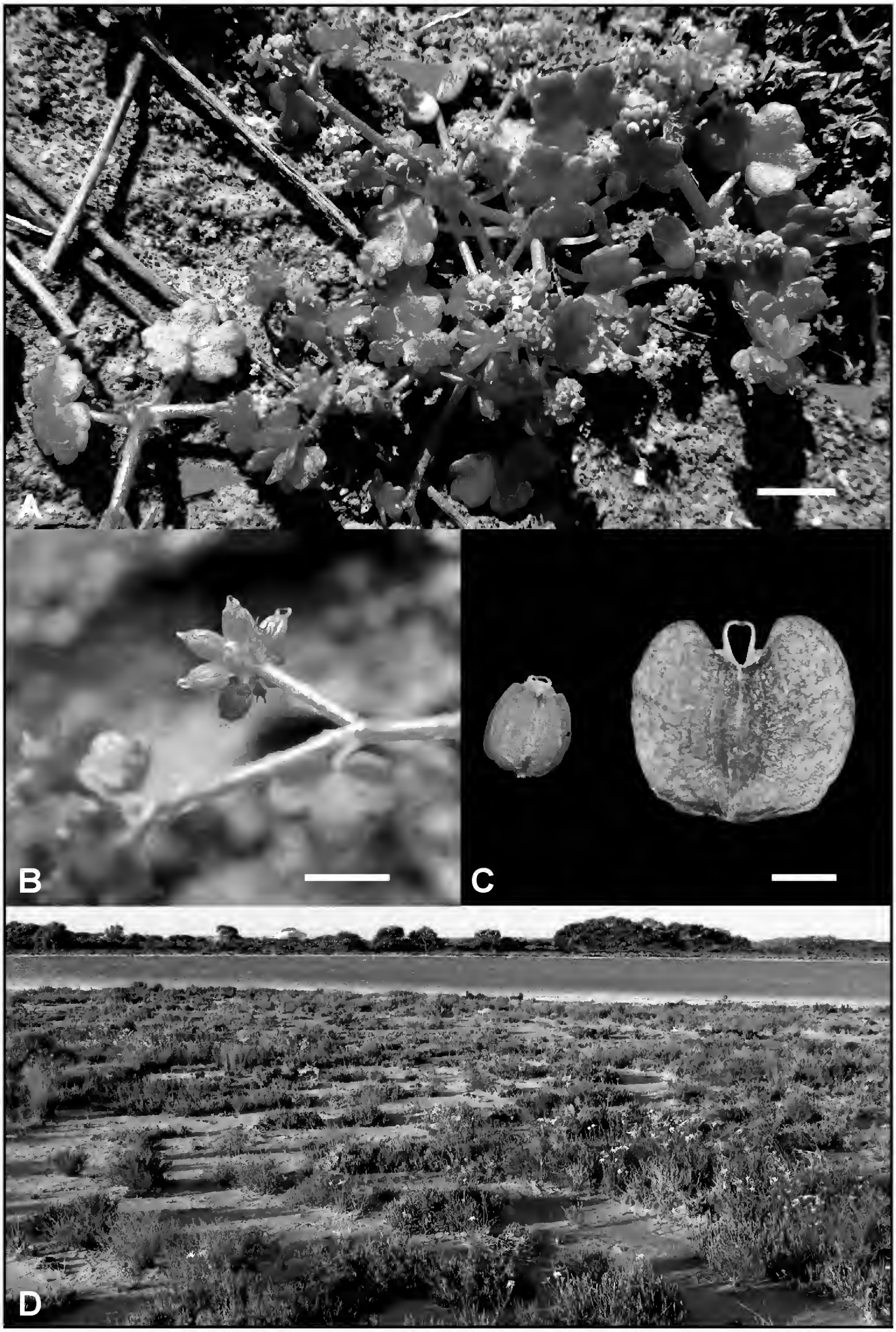

Figure 10. *Hydrocotyle tetragonocarpa*. A – plants with winged fruit morph *in situ* (red arrows indicate infructescences with winged fruits); B – portion of a fertile plant with wingless fruit morph showing andromonoecious umbel; C – mature schizocarps of wingless morph (left) and winged morph (right); D – typical habitat. Scale bars = 5 mm (A, B); 1 mm (C). Vouchers: PERTH 08820872 (A); PERTH 08048517 (B); PERTH 06273211 (wingless fruit) and PERTH 02391325 (winged fruit) (C). Photographs by A. Perkins.

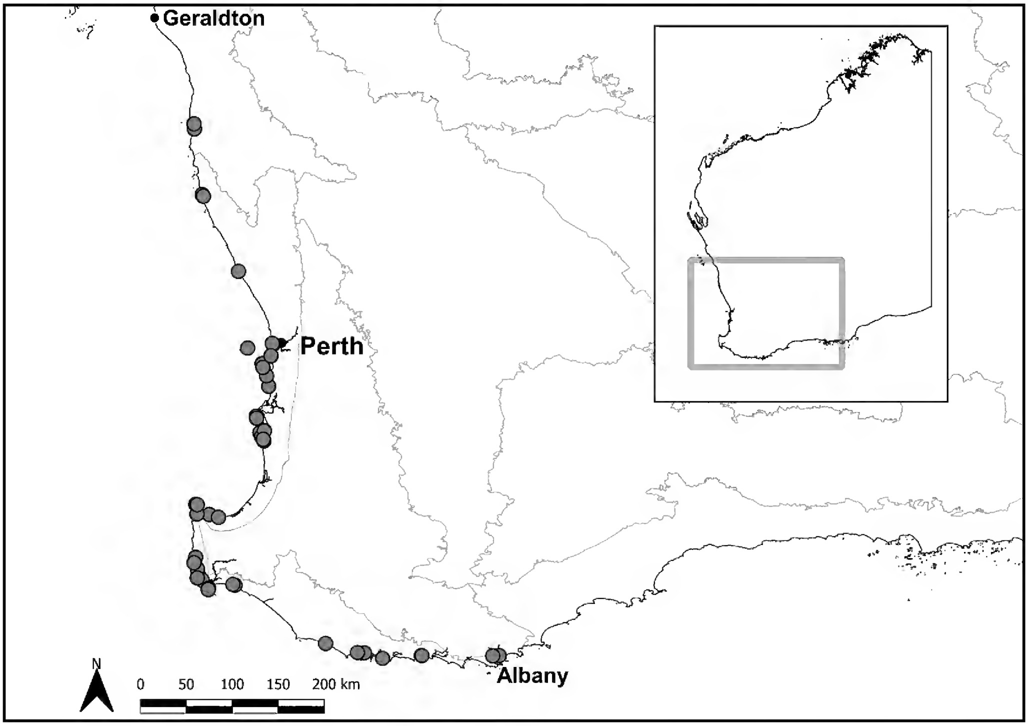

Figure 11. Distribution of *Hydrocotyle tetragonocarpa* (●) based on selected specimens held at CANB, MEL, NSW and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2019).

Etymology. The epithet is derived from the Greek *tetragonus*, 'four-angled', and *-carpus*, '-fruit', in reference to the four-angled fruit of the wingless fruit morph (Figure 10B,C). The common name 'Limestone Pennywort' is here suggested.

Affinities. This species is distinct from all allied annual species of *Hydrocotyle* by having winged and wingless (heterocarpic) fruit. However, it is similar in its vegetative morphology and general habit to taxa such as *H. diantha*, *H. scutellifera* and *H. perplexa*, all of which overlap in their geographic range. Recent molecular phylogenetic analyses (Perkins 2019a) place *H. tetragonocarpa* within a clade of annual *Hydrocotyle* that have persistent floral bracts, referred to as the bracteate annuals. *Hydrocotyle tetragonocarpa* shares these character traits and is sister to *H. plebeya* in phylogenetic reconstructions from combined data analyses of nuclear and chloroplast DNA markers (Figure 1).

Typification. MEL 8187 is selected as an appropriate lectotype of *H. tetragonocarpa* as it bears flowering umbels, mature fruit and it conforms to the protologue (Bunge 1845).

Notes. Two unusual characters occurring in *H. tetragonocarpa* are heterocarpy and andromonoecy. Heterocarpy is rare amongst members of Araliaceae and previously was only known to occur in populations of *Trachymene pilosa* Sm., in which both heterocarpy and heteromericarpy are expressed in various combinations, encompassing five distinct schizocarpic variants (Keighery & Rye 1999). In contrast, andromonoecy is relatively common amongst members of the Araliaceae (Schlessman 2010) and has evolved on at least two occasions within Australian species of *Trachymene* (Henwood

et al. 2010). However, species of *Hydrocotyle* are regularly reported as being monoecious (Bentham 1867; Henwood *et al.* 2010) and the consistent occurrence of andromonoecy in *H. tetragonocarpa* is now considered novel to the genus (Perkins 2019a).

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Update on generic and specific nomenclature in *Paracaleana* (Drakaeinae), Caladeniinae and a new name in *Caladenia* (Orchidaceae)

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Abstract

Hopper, S.D. & Brown, A.P. Update on generic and specific nomenclature in *Paracaleana* (Drakaeinae), Caladeniinae and a new name in *Caladenia* (Orchidaceae). *Nuytsia* 30: 279–285 (2019). Accepting guidance on stability of names from the Preamble to successive International Codes of Botanical Nomenclature, and in the interests of minimizing name changes consistent with present scientific evidence, we propose that the Australian orchid genus *Paracaleana* should be maintained as a distinct genus from *Caleana*, and that *Caladenia* remains best recognised as distinct from *Cyanicula*, *Ericksonella*, *Pheladenia*, *Glossodia* and *Elythranthera*. Recent proposals to lump these genera unnecessarily creates new names in the absence of compelling new scientific evidence to do so. A new name, *Caladenia varians* Hopper & A.P.Br., is erected to replace *C. vulgata* Hopper & A.P.Br. The type of *C. vulgata* matches *Caladenia incensum* Hopper & A.P.Br., and the former species is therefore rendered synonymous with the latter.

Introduction

We have dealt previously with the complex history and ongoing taxonomic upheaval regarding generic and specific concepts in Australian orchids, especially in the subtribes Caladeniinae and Thelymitrinae/Drakaeinae (Hopper & Brown 2004, 2006; Hopper 2009). We have steadfastly considered that nomenclatural changes should be minimalized consistent with the scientific evidence, as proposed in the Preamble to successive International Codes of Botanical Nomenclature, which aims at:

'... the provision of a stable method of naming taxonomic groups, avoiding and rejecting the use of names that may cause error or ambiguity or throw science into confusion. Next in importance is the avoidance of the useless creation of names.' (McNeil *et al.* 2012).

Others working on Australian orchids hold opposing views to this maxim, and continue to change names unnecessarily in our view. Moreover, some (not all) Australian herbaria have accepted this latest round of superfluous name changing, and international lists are beginning to follow suit (e.g. World Checklist of Selected Plant Families, https://wcsp.science.kew.org, accessed 19 February, 2019). Here, we briefly address this issue and provide a necessary new name in *Caladenia* R.Br.

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Paracaleana (Drakaeinae)

Miller and Clements (2014) analysed ITS rDNA sequences of 25 Thelymitrinae/Drakaeinae species and obtained strong support for several genera as monophyletic, including the sisters *Paracaleana* Blaxell and *Caleana* R.Br. Essentially, increased taxon sampling and evidence from new DNA sequences reported by Miller and Clements (2014) confirmed the phylogenetic relationship of these two genera already established as sisters when we revised *Paracaleana* (Kores *et al.* 2001; Hopper & Brown 2006). Yet Miller and Clements (2014), despite clear evidence of reciprocal monophyly, chose to synonymise *Paracaleana* into *Caleana*, and Clements (in Miller and Clements 2014) made the 11 new combinations accordingly. This, in our view, is in contravention of the aim of avoiding the useless creation of names (McNeil *et al.* 2012). In the interests of nomenclatural stability, we continue to recognise *Paracaleana* as a genus distinct from *Caleana*, and recognise the following species in *Paracaleana*:

Paracaleana alcockii Hopper & A.P.Br.
Paracaleana brockmanii Hopper & A.P.Br.
Paracaleana disjuncta D.L.Jones
Paracaleana dixonii Hopper & A.P.Br.
Paracaleana ferricola A.P.Br. & G.Brockman (see Brown & Brockman 2019)
Paracaleana gracilicordata Hopper & A.P.Br.
Paracaleana granitica Hopper & A.P.Br.
Paracaleana hortiorum Hopper & A.P.Br.
Paracaleana lyonsii Hopper & A.P.Br.
Paracaleana minor (R.Br.) Blaxell
Paracaleana nigrita (J.Drummond ex Lindl.) Blaxell
Paracaleana parvula Hopper & A.P.Br.
Paracaleana terminalis Hopper & A.P.Br.
Paracaleana triens Hopper & A.P.Br.

Genera and species in Caladeniinae

Clements *et al*. (2015) enlarged previous sampling of Caladeniinae species to 54 in a molecular phylogenetic study of DNA sequences based on nuclear ribosomal ITS and five plastid regions. This study, again, confirmed the phylogenetic relationships of genera and subgenera already established for the *Caladenia* alliance based on DNA analyses available when we published our latest formal taxonomic review (Hopper & Brown 2004; Hopper 2009). Strong bootstrap support was evident at these taxonomic levels except for the unresolved sister relationship of the two subgenera of *Cyanicula* Hopper & A.P.Br. Further study involving next generation sequencing is required to confirm or falsify the sister relationship of these subgenera. Until this is done we see no case for formally changing names.

At a higher taxonomic level, surprisingly given earlier narrow concepts of *Caladenia* and formal changes effected by Jones and Clements (2001), Clements *et al*. (2015) recently chose to enlarge our concept of *Caladenia* to also include *Cyanicula*, *Ericksonella* Hopper & A.P.Br., *Pheladenia* D.LJones & M.A.Clem., *Glossodia* R.Br. and *Elythranthera* A.S.George. Again, we see this as another example where the avoidance of the useless creation of names (McNeil *et al.* 2012) has not been practised. We reject these unnecessary nomenclatural changes, and maintain our view of generic and subgeneric relationships in the *Caladenia* alliance as previously published (Hopper & Brown 2004; Hopper 2009) in the interests of minimizing name changes consistent with present scientific evidence.

Clements *et al*. (2015) provide some new morphological evidence in support of their taxonomic conclusion for lumping several currently recognised genera into *Caladenia*. Their rationale was to

examine sequentially each character said to be diagnostic of genera and to plot such characters onto their phylogeny. While we are content with their ascription of most characters across clades, we disagree with their treatment of the swollen barrel-shaped basal cell in trichomes. Rather than treat this as a single character, Clements *et al*. (2015) combined it with the presence or absence of glands on the trichome. This enabled them to argue that the synapomorphy for *Caladenia/Ericksonella* as we recognised the clade was, in fact, rampantly homoplasious. The presence/absence of glands on trichomes is indeed homoplasious. The presence of a swollen barrel-shaped basal cell, in contrast, is a synapomorphy for *Caladenia* + *Ericksonella*. We decided to separate *Ericksonella* from *Caladenia* on DNA evidence, which is even more compelling in the study with increased taxon sampling by Clements *et al*. (2015).

We are not as troubled as Clements *et al*. (2015) were that generic-level characters of value in combination in the Caladeniinae were homoplastic when examined individually. The practical issue of identification of genera we recognise is easily achieved when suites of characters are considered, rather than individual characters.

The challenge with generic delimitation in the Caladeniinae is that individual characters are rarely synapomorphic, and hence genera may be recognised in different ways. Molecular phylogeny has provided scientific rigour in establishing genetic relationships, particularly as the sampling of taxa and genetic regions have increased. Clements *et al*. (2015) make a worthwhile contribution in this context. However, where to cut the phylogenetic tree at formal taxonomic levels remains arbitrary and debateable in several cases as their paper reinforces. This is why we place emphasis on nomenclatural stability when present scientific evidence remains equivocal. We suspect that next generation sequencing holds hope for resolution of many of the contentious parts of the Caladeniinae tree. It is premature to lump genera as Clements *et al*. (2015) have done, just as it was to split *Caladenia* so finely in an earlier paper (Jones & Clements 2001).

After a period of some stability in species concepts in the *Caladenia* alliance following publication of our papers (Hopper & Brown 2001, 2004), Brundrett (2014) foreshadowed another phase of taxon lumping may commence. He did not define the species concept that would be used to validate such revisionary work, either in text or the Glossary. It was intimated that many species we described as new taxa through applying the biological species concept (Hopper & Brown 2001, 2004; Hopper 2009) were problematic morphologically or genetically. Terms like 'endless forms', borrowed from Charles Darwin, were used to create an unquantified impression that decisions on the status of taxa were essentially arbitrary and lack scientific rigour. However, Brundrett (2014) used only a selection of the diagnostic taxonomic characters we identified in our taxonomic revisions, reducing descriptions into a shorter list of readily observed characters irrespective of their value for identifying individual taxa. Until a more rigorous revision is undertaken, testing species concepts against explicit definitions with modern next generation DNA sequencing markers and detailed population morphometrics, we remain content in recognising taxa hitherto named by us and more recently by Brown and Brockman (2007, 2015).

A new name in *Caladenia*

One taxon that does need formal attention now is *Caladenia vulgata* Hopper & A.P.Br. Inadvertently, the holotype of this species was incorrectly chosen and clearly belongs to *C. incensum* Hopper & A.P.Br. We effect that synonomy here, and choose a new name, *Caladenia varians* Hopper & A.P.Br. for the taxon previously regarded as *C. vulgata*.

Caladenia incensum Hopper & A.P.Br., *Nuytsia* 14(1/2): 241 (2001). *Calonema incensum* (Hopper & A.P.Br.) D.L.Jones & M.A.Clem., *Orchadian* 13(10): 455 (2002), *nom. inval.*; *Calonemorchis incensa* (Hopper & A.P.Br.) D.L.Jones & M.A.Clem., *Orchadian* 14(1): 36 (2002); *Jonesiopsis incensa* (Hopper & A.P.Br.) D.L.Jones & M.A.Clem., *Orchadian* 14 (4): 182 (2002). *Typus:* Chiddarcooping Hill Nature Reserve, near southern boundary, 30°54'S, 118°41'E, Western Australia, 17 August 1988, *A. Brown* 829 (*holo*: PERTH 01708112; *iso*: AD 156477, CANB 556721, K, MEL 2279957, NSW 520141).

Caladenia vulgata Hopper & A.P.Br., *Nuytsia* 14 (1/2): 280 (2001), *pro parte* as to type. *Typus*: Kalbarri National Park, 17 km south of Eurardy Homestead, 13.1 km north of Murchison River Bridge, 500 m south-west of Highway, 27°43'S, 114°40E, Western Australia, 23 August 1983, *S.D. Hopper* 3330 (*holo*: PERTH 00273600; **iso**: AD 168970, CANB 598564.1, K).

Caladenia varians Hopper & A.P.Br., *sp. nov.*

Typus: Coorow Greenhead Road, 25 km west of Midlands Road. south-west of Coorow, Western Australia, 4 September 2010, *G. Brockman* GBB 2621 (*holo*: PERTH 08420068; *iso*: CBG).

Caladenia vulgata Hopper & A.P.Br., *Nuytsia* 14(1/2): 280 (2001), *pro parte* not as to type. *Caladenia varians* Hopper & A.P.Br. subsp. *varians*, in N. Hoffman & A. Brown, *Orchids of South-West Australia*, 2nd edn. p. 33 (1992), *nom. nud.*

Illustrations. N. Hoffman & A. Brown, *Orchids of South-West Australia*, 2nd edn, p. 33 [as *Caladenia varians* subsp. *varians*] (1992); N. Hoffman & A. Brown, *Orchids of S-W. Austral.*, rev. 2nd edn with suppl., p. 33 (1998) and 3rd edn, p. 37 (2011); A. Brown, P. Dundas, K. Dixon & S. Hopper, *Orchids of W. Austral.*, p. 36, Figure A (2008); G. Backhouse, *Spider-orchids - the Genus* Caladenia *and its Relatives in Austral.*, p. 258–259 (2011) and rev. 2nd edn, p. 276–277 (2018); A. Brown, K. Dixon, C. French & G. Brockman, *Field Guide to the Orchids of W. Austral.*, p. 72 (2013); N. Hoffman, A. Brown & J. Brown, *Orchids of S-W. Austral.*, 4th edn. p. 38 (2019) [all as *C. vulgata*].

Plants solitary or in small clumps. *Leaf* 50–220 mm long, 3–5 mm wide, linear, erect, incurved in cross section, pale green, the basal 1/3 usually irregularly blotched with red-purple. *Scape* 150–300 mm tall. *Flowers* 1 to 3, 70–100 mm across, cream, with pale maroon lines, spots and blotches; floral odour faintly sweet to putrid. *Petals and sepals* linear-lanceolate, scarcely glandular-hirsute on the outside and glabrous on the inside in the basal 1/5 to 1/4 then abruptly narrowing to a red-black, densely glandular-hairy, long-acuminate filamentous apex lacking a swollen osmophore. *Dorsal sepal* 45–100 mm long, 2–3 mm wide, erect and slightly incurved. *Lateral sepals* 50–110 mm long, 2–4 mm wide, spreading obliquely downwards near the base and pendulous towards the apex. *Petals* 45–100 mm long, 2–3 mm wide, spreading horizontally near the base and pendulous towards the apex. *Labellum* obscurely 3-lobed, cream with pale to deep red stripes, spots and blotches, stiffly articulated on a claw 1–1.5 mm wide; lamina 10–15 mm long, 7–11 mm wide, narrowly triangular to triangular (rarely rhomboidal) in outline, erect with entire margins in the basal 1/3, nearly horizontal in middle 1/3 and apical 1/3 prominently recurved; lateral lobes with broadly truncate to triangular forwardly uncinate cream to red-marked marginal calli which are decrescent towards the mid lobe; lamina calli cream, often with pale red markings, dull on top, broadly to narrowly anvil-shaped, the longest *c.* 1 mm tall, in 8–12 pairs in two rows extending over about 1/2 the length of the labellum and slightly decrescent towards the apex. *Column* 8–12 mm long, 4–6 mm wide, narrowly-winged, opaque cream with pale red stripes and blotches, sparsely hirsute with short glandular hairs on outer surface. *Anther* 2–3 mm long, 2–3 mm wide, greenish yellow. *Pollinia* >2 mm long, kidney-shaped,

flat, yellow, mealy. *Stigma* 2–2.5 mm long, 2–2.5 mm wide. *Capsule* not seen. (Figure 1)

Diagnostic features. *Caladenia varians* may be distinguished from all other members of the genus by the following combination of characters: Flowers cream, with pale maroon lines, spots and blotches; Petals and sepals with a red-black, densely glandular-hairy, long-acuminate filamentous apex lacking a swollen osmophore: Labellum lateral lobes with broadly truncate to triangular forwardly uncinate marginal calli; lamina calli broadly to narrowly anvil-shaped in 8–12 pairs in two rows extending over about 1/2 the length of the labellum.

Selected specimens examined. WESTERN AUSTRALIA: Coolinup Rd, 3 km S of Kettles Road. Track follow power line to W, 23 Sep. 2004, *G. Brockman* 1417 (PERTH); 500m SE of Beaumont Wheat facility; Beaumont Nature Reserve, 23 Sep. 2004, *G. Brockman* GBB 1477 (PERTH); Reserve 10147, Robinson Rd, Woodanilling, 8 Oct. 2014, *G. Byrne* 5274 (PERTH); 16 miles NW of Badgingarra, 1 Sep. 1966, *A.S. George* 7805 (PERTH); 22 km SSE of Kalbarri, 45 km WNW of Binnu, 24 Aug. 1983, *S.D. Hopper* 3342 (PERTH); 26 km ENE of Wilga siding, 6 Oct. 1983, *S.D. Hopper* 3477 (PERTH); 300 metres E of Mandurah-Fremantle Rd on Paganoni Rd, 12 km NNE of Mandurah, 12 Sep. 1984, *S.D. Hopper* 4136 (AD, CANB, PERTH); Yalgorup National Park, 4.1 km W of Mandurah – Bunbury Rd on Preston Beach Rd, 12 Sep. 1984, *S.D. Hopper* 4145 (AD, CANB, K, PERTH); Yalgorup National Park, 1.2 km W of Mandurah - Bunbury Rd on Preston Beach Rd, 12 Sep. 1984, *S.D. Hopper* 4149 (CANB, PERTH); 26 km NW of Kojonup, intersection of Collie – Changerup and Stirlings Rd, 11 Sep. 1985, *S.D. Hopper* 4543 (PERTH); Dragon Rock Nature Reserve (36128), 31 km N of Newdegate,

Figure 1. *Caladenia varians*. A – flowers showing their cream and pale maroon colouration and pendulous petals and lateral sepals with densely glandular-hairy, long-acuminate filamentous apexes; B – labellum, showing the broadly truncate to triangular forwardly uncinate marginal calli and broadly to narrowly anvil-shaped lamina calli. Photographs by A.P. Brown.

13 Sep. 1985, *S.D. Hopper* 4567 (CANB, PERTH); Kalbarri Road, *c.* 9 km WSW of Murchison House Station turnoff, 8 Aug. 1986, *S.D. Hopper* 5178 (PERTH); Great Northern Hwy, 1 km NNE of Wubin, 23 Aug. 1988, *S.D. Hopper* 6504 C (PERTH); SE foot and W foot of Totadgin Rock, *c.* 47 km NE of Kellerberrin, 14 Sep. 1988, *S.D. Hopper* 6610 (PERTH); *c.* 12 km W of Z Bend Gorge, Kalbarri National Park, and 10 km SSW of T- junction on road to Z Bend Gorge, 8 Aug. 1990, *S.D. Hopper* 7815 (PERTH); Bullsbrook Nature Reserve, 1 km N of Pearce, 9 Aug. 1992, *G.J. Keighery* 13514 (PERTH); Pikaring West Nature Reserve, Old Beverley Rd; ca 25 km E Quairading, 18 Aug. 1998, *G.J. Keighery* 16388 (PERTH); Bridge crosses salty creekline on the Coorow-Greenhead Rd 7.6 km E of the junction of Carger Rd and the Coorow-Greenhead Rd, 29 Aug. 2014, *R. Phillips* 0269 (PERTH); Peak Charles car park area, 6 Aug. 1978, *D.R. Voigt* 46pp (PERTH).

Phenology. Flowering from August to October. Fruiting from October to November.

Distribution and habitat. Widespread throughout the south-west from north of Kalbarri to Augusta and eastwards to Condingup. Favours sandy soils in a range of communities including coastal heath, inland mallee heath, woodlands and forests.

Conservation status. Not considered rare or under immediate threat.

Etymology. From the Latin *varians* (varying), in reference to the variable morphology of the species over its very large geographic range.

Affinities. Caladenia varians is most similar to *C. pendens* Hopper & A.P.Br. from which it may be distinguished by its shorter petals 45–100 × 2–3 mm (*cf.* 60–120 × 3–5 mm in *C. pendens*), generally smaller labellum 10–15 × 7–11 mm (*cf.* 11–19 × 9–12 mm in *C. pendens*) and smaller column 8–12 × 4–6 mm (*cf.* 10–15 × 5–7 mm in *C. pendens*). It is also similar to *C. exilis* Hopper & A.P.Br. from which it may be distinguished by its larger labellum 10–15 × 7–11 mm cf. (8–12 × 5–7 mm in *C. exilis*).

Caladenia varians may be found growing with *C. nobilis* Hopper & A.P.Br., which has much larger flowers with a broader labellum 12–25 × 12–16 mm and larger column 13–18 × 5–10 mm. It may also be found with *C. hiemalis* Hopper & A.P.Br., which generally has shorter petals 35–60 mm long and an earlier flowering season between June and August, and with *C. meridionalis* Hopper & A.P.Br., which also flowers earlier (June–August) and has stiffly held petals and sepals with dark glandular apices. *Caladenia meridionalis* is also confined to the south coast whereas *C. varians* is widespread from Kalbarri to Condingup.

Northern populations of *C. varians* may grow near to *C. incensum* but the latter species differs in its broader leaf 4–15 mm across, broader tepals 3–6 mm across, short squat calli and its preference for heavier (clay-loam) soils. To the north-west of Northampton, *C. varians* grows with *C. elegans* Hopper & A.P.Br. which differs in its pale yellow colouration, thicker more squat calli and its preference for winter-wet clay soils.

Notes. *Caladenia varians* occasionally hybridises with *C. nobilis* on the Swan Coastal Plain and with *C. wanosa* A.S.George in Kalbarri National Park. Rare hybrids of *C. varians* and *C. drakeoides* Hopper & A.P.Br. found near Pithara are formally named *Caladenia ×hopperi* J.M.H.Shaw (Shaw 2014).

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SHORT COMMUNICATION

Paracaleana ferricola (Orchidaceae), a new, rare species from the south-west of Western Australia

Paracaleana ferricola A.P.Br. & G.Brockman, *sp. nov.*

Type: Canning Mills, Western Australia [precise locality withheld for conservation reasons], 18 November 2017, *G. Brockman* GBB 3571 (*holo*: PERTH 08961646; *iso*: CANB).

Paracaleana sp. Laterite (G. Brockman GBB 3571), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 23 July 2018].

Illustration. A.P. Brown, K.W. Dixon, C.J. French & G. Brockman, *Field Guide to the Orchids of W. Austral.*, p. 305 (2013), as *Paracaleana* sp. 'Darling Range'.

An erect perennial geophytic *herb* to 10 cm high. *Plants* solitary, more rarely in small groups. *Tuber* oblong, 6–11 mm long, 3–6 mm wide, white, annually replaced with a new tuber produced at the end of an elongate descending side-dropper (root-like stolon). *Leaf* solitary, basal, erect to spreading, withered or more rarely fresh at anthesis; *lamina* when fresh 10–20 mm long, 5–8 mm wide, glabrous, thin, narrowly elliptic to ovate, flattened in TS, dark maroon above and below, apex acute to obtuse. *Scape* 6–10 cm tall, wiry, dull brownish maroon and greenish yellow, with floral bract(s) erect, sheathing, foliaceous, acuminate; pedicels 5–15 mm long. *Flowers* solitary, rarely paired, nonresupinate, inverted, glabrous, greenish yellow and pale maroon with darker maroon blotches and markings; floral odour undetectable to humans but known to attract male thynnid wasps. *Sepals* and *petals* similar in shape, narrowly linear, margins revolute, apices narrowly clavate to acute. *Dorsal sepal* 7–10 mm long, 1–1.5 mm wide, splayed downwards, appressed against the column and distinctly elbowed in terminal 1/4 to 1/3, apex narrowly clavate. *Lateral sepals* 7–10 mm long, 1 mm wide, splayed downwards, usually away from the column wings, distinctly elbowed in terminal 1/4 to 1/3, apex not clavate. *Petals* narrower than sepals, 6–9 mm long, 0.5 mm wide, splayed downwards, appressed to column wings, shallowly curved, apex not clavate. *Labellum* motile, stiffly sprung on a long broadly rhomboidal claw 3–5 mm long, 1.5–2 mm wide, attached to the front of the extended column foot, the claw upcurved when set, recurved when sprung, terminating in a triangular apex extending backwards off the base of the labellum lamina; *lamina* 8–10 mm long, 2.5–3 mm wide, undivided, narrowly lageniform, entire, flattened or sometimes with a slight hump at 2/3 its length with a shortly projecting narrowly triangular neck-like narrowly obtuse apex; lamina calli sessile, irregularly hemispheric, smooth, black, glossy, confined to the apical 1/3 to 1/2. *Column* 6–10 mm long, downcurved, 2-winged; the wings 3–4 mm wide, broadly rectangular, incurved, somewhat opaque, greenish to greenish maroon with darker maroon blotches and markings. *Anther* 1.5–2 mm long, 1.5–2 mm wide, yellowish green, obtuse, not terminating in a definite point. *Pollinia* 1.5–2 mm long, four, lamellate, granular, yellow. *Stigma* ovate, 1.5–2 mm long, 1.5–2 mm wide, dull yellow. Ovary narrowly pyramidal, greenish yellow with brownish maroon longitudinal stripes. *Capsule* not seen. (Figure 1)

Diagnostic features. *Paracaleana ferricola* may be distinguished from all other members of the genus by the following combination of characters: leaf elliptic to ovate, dark maroon above and below, apex

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Figure 1. *Paracaleana ferricola*. A – flowering plants *in situ* at the type locality showing the sometimes paired flowers, thin wiry stems and basal leaves which are often withered at anthesis; B – flower, showing the narrow sepals and petals, broadly winged column and motile labellum with calli confined to the apical 1/3 to 1/2; C – habitat showing the iron-rich lateritic soils occupied by the species and associated vegetation including *Banksia sessilis* and *Xanthorrhoea preissii*. Photographs by A.P. Brown.

acute to obtuse, withered or rarely fresh at anthesis; labellum lamina entire, flattened, sometimes with a slight hump at 2/3 its length, with calli confined to the apical 1/3 to 1/2.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 6 Dec. 2005, *G. Brockman* 1694 (PERTH); 30 Oct. 2006, *G. Brockman* 1986 (PERTH); 5 Nov. 2002, *F. & J. Hort* 1892 (PERTH); 14 Nov. 2002, *F. & J. Hort* 1908 *& G. Brockman* (PERTH).

Phenology. Flowering from late October to early December. Fruiting December.

Distribution and habitat. Found over a small geographic range east of Perth, growing in lateritic soils containing an unusually high amount of Haematite. The habitat is open *Allocasuarina fraseriana*, *Corymbia calophylla*, *Eucalyptus marginata* woodland over *Banksia sessilis* and *Xanthorrhoea preissii* (Figure 1).

Conservation status. Currently listed as Priority Two under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *P.* sp. Laterite (G. Brockman GBB 3571). The species is known from two small populations 1.8 km apart in Korung National Park, these together comprising just 30 mature plants in an area threatened by altered fire regimes, dieback and habitat damage by off-road vehicles.

Etymology. The epithet *ferricola* is derived from the Latin *ferrum* (iron) and the suffix *-cola* (dweller or inhabitant) in reference to the iron-rich lateritic soils occupied by this species.

Affinities. *Paracaleana ferricola* is most similar to *P. disjuncta* Hopper & A.P.Br. and like that species has a late flowering period, a leaf that is often withered at anthesis and a small greenish yellow and maroon flower. It is distinguished, however, by its smaller flower with petals and sepals 6–10 mm long (*cf.* 8–12 mm long for *P. disjuncta*), sometimes slightly humped, narrower labellum 2.5–3 mm wide (*cf.* labellum lacking a hump and 3–5 mm wide for *P. disjuncta*), labellum lamina calli confined to the apical 1/3 to 1/2 (*cf.* labellum lamina calli confined to the apical 1/3 for *P. disjuncta*) and narrower column wings, 3–4 mm wide (*cf.* column wings 4–6 mm wide for *P. disjuncta*). Furthermore *P. ferricola* occurs some 250 km to the north of the nearest known population of *P. disjuncta* and occupies lateritic soils *vs* the sandy soils favoured by that species.

At the type location *P. ferricola* grows with *P. nigrita* (Lindl.) Blaxell and *P. brockmanii* Hopper & A.P.Br., but flowers over a month after *P. nigrita* has finished flowering and is in late flower when *P. brockmanii* begins flowering. It is distinguished from *P. nigrita* by its labellum either lacking a hump or with a slight hump at 2/3 its length (*cf.* labellum prominently humped at 1/2 its length for *P. nigrita*) and its lamina calli confined to the apical 1/3 to 1/2 the length of the labellum (*cf.* lamina calli confined to the apical 2/3 the length of the labellum for *P. nigrita*).

From *P. brockmanii*, *P. ferricola* is distinguished by its smaller flowers with petals and sepals 6–10 mm long (*cf.* 10–15 mm long for *P. brockmanii*), smaller, narrower labellum 8–10 × 2.5–3 mm (*cf.* 9–12 × 4–7 mm for *P. brockmanii*) and shorter column 6–10 mm long (*cf.* 10–12 mm long for *P. brockmanii*).

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The *Hibbertia polystachya–H. spicata* (Dilleniaceae) species group in Western Australia

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Abstract

Thiele, K.R. The *Hibbertia polystachya–H. spicata* (Dilleniaceae) species group in Western Australia. *Nuytsia* 30: 291–308 (2019). *Hibbertia spicata* F.Muell. and *H. polystachya* Benth. are widespread in south-western Western Australia, where they are unique in *Hibbertia* Andrews in having flowers in a cincinnus rather than solitary. The boundary between these two species has been problematic, as they mostly differ in the composition and density of indumentum on their sepals and leaves. Close study has revealed that *H. polystachya* is widespread and taxonomically relatively straightforward, while *H. spicata sens. lat.* comprises six distinctive, readily resolvable species (including *H. leptotheca* (J.R.Wheeler) K.R.Thiele *comb. et stat. nov.*, previously *H. spicata* subsp. *leptotheca* J.R.Wheeler) differing in leaf and sepal indumentum, number of flowers in the cincinnus, floral bract shapes, stamen number, and number and arrangement of staminodes. New species described here are *H. capensis* K.R.Thiele *sp. nov.*, *H. asterella* K.R.Thiele *sp. nov.* and *H. subglabra* K.R.Thiele *sp. nov*. The new name *H. prolata* K.R.Thiele is provided for a widespread taxon based on *Hemistephus linearis* J.Drumm. ex Harv. With these species removed, *H. spicata* is recircumscribed and is now more restricted in distribution.

Introduction

Hibbertia spicata F.Muell. was described by Mueller (1860) based on a specimen collected by Walcott and A.F. Oldfield, probably in 1859, at Port Gregory (between Geraldton and Kalbarri). In the protologue, Mueller noted its close affinity with *Hemistephus linearis* J.Drumm. ex Harv., described by Harvey (1855) based on a Drummond specimen from 'Northern Districts'. Bentham (1863) synonymised the latter name under the former (the combination in *Hibbertia* Andrews being unavailable due to the epithet being preoccupied by *H. linearis* R.Br. ex DC.).

Bentham (1863) also described *Hibbertia polystachya* Benth. based on two specimens, a Drummond collection from 'Swan River' and an Oldfield collection from the 'Blackwood River'. He included both species in his sect. *Hemipleurandra* Benth., noting that unlike other species in the section, *H. spicata* and *H. polystachya* have flowers borne in a '1-sided spike' rather than singly. He gave as the key difference glabrous leaves in *H. spicata* compared with hirsute leaves (and sepals) in *H. polystachya*, noting also that the former has staminodes completing the ring of stamens while the latter has no or few staminodes (sometimes with only a single one behind the stamens).

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Wheeler (1984, 1987, 2004) commented on the close relationship between these two species and the difficulty of separating them at times. Wheeler (2004) gave the key difference as the sepals, bracts and young leaves being glabrous or with minute stellate and hooked hairs in *H. spicata c.f.* having fairly long, coarse, simple hairs (sometimes also with underlying minute stellate hairs) in *H. polystachya*. She considered (Wheeler 1984) that the difference in staminodes provided by Bentham (1863) was unreliable, with some specimens from each species having identical staminode arrangements. She further noted that (1) some specimens appear intermediate between the two species, speculating that closer study might reveal that *H. polystachya* and *H. spicata* are conspecific, and conversely that (2) *H. spicata* is morphologically variable within its range, with the implication that it may contain further taxa.

Wheeler (1984) added a third taxon to the group when she described *H. spicata* subsp. *leptotheca* J.R.Wheeler for specimens occurring along the coastal plain from Lancelin, north of Perth, southwards to Yalgorup National Park. These differ from typical subsp. *spicata* in having longer, more slender anthers, fewer (or no) staminodes, and outer sepals that are glabrous or almost so. She noted that subsp. *leptotheca* is geographically and ecologically separated in the Perth region from subsp. *spicata*, the former occurring on coastal limestones and the latter being absent from the coastal plain in that region (although elsewhere occurring on coastal limestones e.g. at North West Cape).

Hibbertia polystachya and *H. spicata* are striking amongst *Hibbertia* species in south-west Western Australia in having flowers borne in cincinni (often described as 'one-sided spikes'; Figure 1), all other species in the area having sessile or pedicellate flowers borne singly and terminating shoots (sometimes appearing axillary to leaves when terminating axillary short-shoots or following overgrowth of an axillary shoot arising below the flower). Two other groups of *Hibbertia* also have cincinnate inflorescences: a northern Australian species group including *H. muelleri* Benth. and *H. candicans* (Hook.f.) Benth., and a New Caledonian radiation including *H. pancheri* (Brongn. & Gris) Briq. and *H. vieillardii* (Brongn. & Gris) Gilg. Despite striking similarities in their inflorescences, the molecular phylogeny of Horn (2005) resolves these as separate clades, with *H. spicata* in a clade with other (single-flowered) species from south-western Australia such as *H. acerosa* (R.Br. ex DC.) Benth. (*H. polystachya* was not included in the phylogeny).

Horn (2005) analysed inflorescence structure and floral development in *H. polystachya* and concluded that the cincinnus is a highly sylleptic sympodium; that is, each flower terminates its axis, with subsequent flowers 'higher up' in the inflorescence derived from axes produced from the axil of the subtending bract of the terminal flower and with the bract carried sylleptically up the axis so that it appears to subtend the next-distal flower. Usually only one flower is open in each cincinnus at any given time.

This study assessed morphological variation in *H. polystachya* and *H. spicata* to determine whether the two taxa should be retained as separate or whether the variation noted by Wheeler (1984) indicates that further taxa should be recognised. Significant variation was found, in the indumentum of young stems, leaves and sepals, in the number of flowers and shape and arrangement of bracts in the cincinnus, in flower size, in the number of stamens, and in the number, shape and arrangement of staminodes. The morphological variation is geographically and ecologically correlated and consistent with the recognition of four new species and the raising of *H. spicata* subsp. *leptotheca* to species rank. The group thus comprises seven distinct and readily recognisable species.

Figure 1. Flowering branches of two species in the *Hibbertia spicata-H. polystachya* group. A – *H. prolata* (Zig Zag Road, Gooseberry Hill, 28 Sep. 2019); B – *H. asterella* (*K.R. Thiele* 5590, 2 Oct. 2019). Photos by K.Thiele.

Methods

All specimens at PERTH were examined. Types of *Hibbertia spicata*, *H. polystachya* and *Hemistephus linearis* were viewed at MEL; other type specimens were viewed on JSTOR *Global Plants* (https://plants.jstor.org/). Leaf and sepal measurements are based on dried specimens; petal, stamen and style measurements are based on herbarium material rehydrated in hot water with a little detergent. Maps are based on all specimens held at PERTH and are drawn using IBRA v. 7 (Department of the Environment 2013) bioregion and subregion boundaries.

Key to species in the *Hibbertia spicata–H. polystachya* species group

1. Outer sepals moderately to densely stellate-hairy, with no or few simple hairs

2. Whole plant (young stems, leaves and sepals) densely stellate-pubescent; stamens 10–12; most staminodes opposite the stamens .... **1. H. asterella**

2: Young stems and leaves ±glabrous; stamens 12–16; most staminodes behind the stamens .... **2. H. capensis**

1: Outer sepals glabrous to pilose, mostly with simple or hooked hairs (stellate hairs, when present, a minor component of the indumentum)

2. Abaxial leaf lamina and midrib glabrous .... **3. H. subglabra**

2: Abaxial leaf lamina where exposed (and where hidden by the recurved margins) densely stellate-pubescent, the midrib often glabrous

3. Flowers (6–)8–14 per cincinnus, overlapping; cincinnus bracts distinctly heteromorphic, each flower (except the lowermost) subtended by a ±linear and a broadly ovate to triangular bract .... **4. H. spicata**

3: Flowers (1)2–6(7) per cincinnus, the lowermost at least well-separated; cincinnus bracts not distinctly heteromorphic, each flower (except the lowermost) subtended by two ±linear to ovate bracts differing mainly in length

4. Adaxial leaf laminas and outer sepals quite glabrous .... **5. H. leptotheca**

4: Adaxial leaf laminas and/or outer sepals hairy

5. Adaxial leaf laminas ±glabrous; sepals mostly with hooked hairs .... **6. H. prolata**

5: Adaxial leaf laminas pubescent to pilose with simple hairs; sepals with a mix of simple, stellate and hooked hairs .... **7. H. polystachya**

Taxonomy

1. Hibbertia asterella K.R.Thiele, *sp. nov.*

Type: Bokal Road North, 1.4 km from Boyup Brook-Arthur River Road, Western Australia, 2 October 2019, *K.R. Thiele* 5590 (*holo*: PERTH 09085122; *iso*: AD, CANB, MEL)

Prostrate, compact or spreading *shrubs* to 0.3(–0.7) m high, multi-stemmed at base and resprouting from the rootstock after fire; young stems moderately to densely stellate-pubescent; older stems with smooth to scabrid, papery, dull or silvery bark decorticating in flakes and strips. *Leaves* spreading-erect, scattered, linear, (10–)12–25 mm long, 1–2 mm wide; margins revolute but the abaxial lamina usually exposed; adaxial lamina coarsely stellate-pubescent with tubercle-based hairs (rarely with scattered simple hairs amongst the stellate ones); abaxial lamina finely and densely stellate-pubescent, the midrib with indumentum as for the adaxial surface; apex obtuse and recurved-apiculate. *Inflorescences* comprising 2–4-flowered cincinni, the lowermost flowers usually well-separated; cincinna axis with indumentum as for the stems; bracts ±homomorphic, narrowly ovate to linear, the lowermost 3–6 mm long, 0.8–2 mm wide, often leaf-like in having recurved margins, a prominent midrib, and indumentum as for the leaves. *Sepals* ovate, 5–6 mm long, abaxially densely tuberculate-stellate; midribs prominent; outer sepals acute; inner sepals similar to the outer but smaller. *Petals* yellow, broadly obovate, 7–10 mm long, shallowly to deeply emarginate. *Stamens* 10–12, all on one side of the gynoecium, shortly fused by their filaments; anthers oblong, 1.5–2 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* 10–16, a few lateral to but most opposite the stamens. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, 1–1.5 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen. (Figure 1A)

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the densely and coarsely stellate-pubescent leaves, cincinnus bracts and sepals.

Other specimens examined (all PERTH). WESTERN AUSTRALIA: Wingebellup Rd, E of Unicup Rd and N of Kulanilup Reserve, 15 Nov. 2017, *G. Byrne* 6738; Dardadine Rd South between Bunce King Rd and O'Connor Rd, ESE of Dardadine, 8 Nov. 1993, *V. Crowley* DKN392A; NE of Dinninup, 28 Oct. 1998, *R. Davis* 8228; *c.* 23 km NW from Darkan Rock, 25 Aug. 1997, *A. Gundry* 583; Yarnup Nature Reserve, 25 Oct. 1997, *G.J. Keighery & N. Gibson* 2631; Kululinup [Kulunilup] Nature Reserve, 26 Oct. 1997, *G.J. Keighery & N. Gibson* 2746; Albion Rd, *c.* 32 km SW of Kojonup, 29 Oct. 1997,

C.M. Lewis 311; Graham Rd, SW Narrogin, 8 Oct. 1998, *G. Warren* 43; North Kulikup, Darkan, 14 Sep. 2005, *A. Webb* BNC970; Between Albany Hwy and Boddington, *c.* 2 km from Albany Hwy, 26 Sep. 1983, *J.R. Wheeler* 2202; Just W of Cuballing, *c.* 1.5 km along Cuballing West Rd, 10 Oct. 2001, *J.R. Wheeler* 4135.

Phenology. Flowers in September and October, most records being from the latter month.

Distribution and habitat. Scattered in south-west Western Australia from the vicinity of Boddington to Yarnup Nature Reserve west of Frankland River (Figure 2), growing in grey to red-brown loamy, clay and sandy soils over granite and laterite, in open marri, jarrah and wandoo woodlands.

Conservation status. Widespread and scattered, including in several nature reserves, and not considered to be at risk.

Etymology. From the Latin *aster* (a star) with the diminutive *-ella*, in reference to the leaves and sepals that are densely stellate-pubescent.

Notes. *Hibbertia asterella* is distinctively grey-hoary due to the abundant tubercle-based stellate

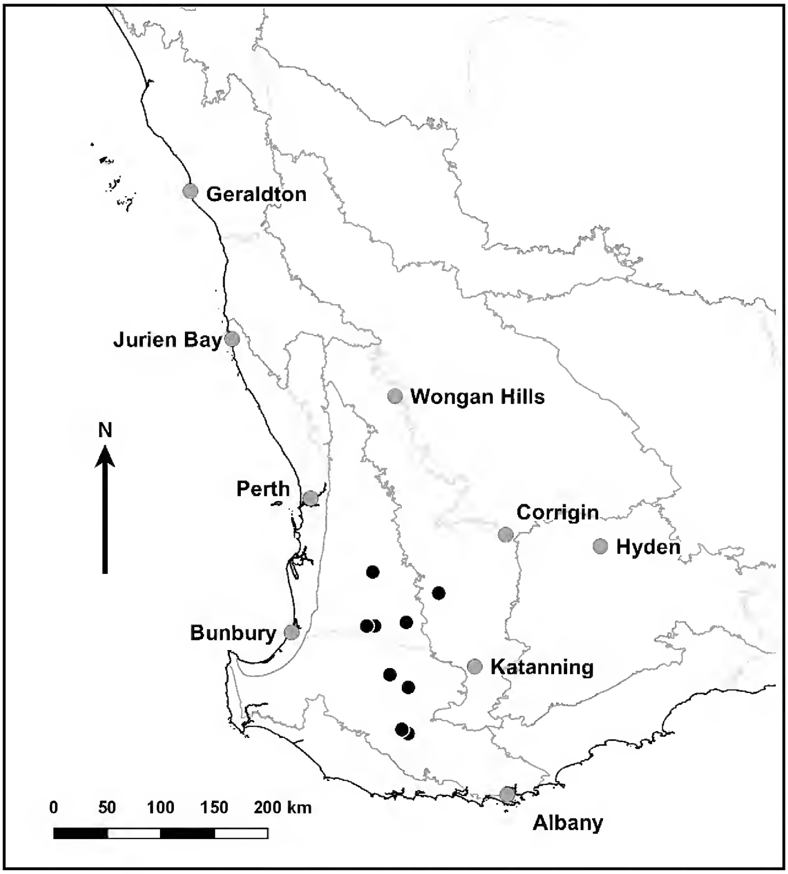

Figure 2. Distribution of *Hibbertia asterella*.

hairs on all parts. While minute stellate hairs are variably found in some other taxa in this group (e.g. *H. prolata*, *H. polystachya*) they are a minor component of the indumentum (except in *H. capensis* which has minutely stellate-hairy sepals). Most specimens of *H. asterella* lack simple hairs amongst the stellate ones.

2. Hibbertia capensis K.R.Thiele, *sp. nov.*

Type: Track north of Charles Knife Road; summit of Cape Range, Cape Range National Park, Western Australia, 17 June 2019, *G.J. Keighery & K. Lilburn s.n* (*holo*: PERTH 09085165!; *iso*: AD, CANB).

Much-branched, erect, compact *shrubs* to 0.8 m high, multi-stemmed at base and resprouting from the rootstock after fire; young stems sparsely stellate-pubescent with minute hairs; older stems with dull, grey, fissured bark. *Leaves* spreading to erect, scattered, linear, 15–35 mm long, *c*. 1 mm wide; margins tightly revolute to the midrib and hiding the abaxial lamina; adaxial lamina glabrous except for fine hairs at the very base, scattered-tuberculate; abaxial lamina obscured by the recurved margins but when visible densely stellate-pubescent; midrib glabrous; apex acute. *Inflorescences* comprising 2–4(–6)-flowered cincinni, the lowermost flowers well-separated to overlapping; cincinna axis minutely and finely stellate-pubescent; bracts ±heteromorphic with one broader and one narrower and with a ±constricted base, the broader one ovate to broadly ovate or triangular, the lowermost 3–4 mm long, 1–2.5 mm wide, finely stellate-pubescent. *Sepals* very broadly ovate to almost orbicular, 6.5–8 mm long, abaxially very finely and minutely stellate-pubescent; midribs prominent; outer sepals obtuse to subacute; inner sepals similar to the outer but smaller and more obtuse. *Petals* yellow, broadly obovate, 10–13 mm long, shallowly to deeply emarginate. *Stamens* 12–16, all on one side of the gynoecium, shortly fused by their filaments; anthers oblong, 1.8–2 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* 10–12, all behind and lateral to the stamens, filiform. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, 1.8–2 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen.

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the combination of very finely and minutely stellate-pubescent sepals and leaves that are glabrous above and densely stellate-pubescent on the lamina below.

Selected specimens (all PERTH). WESTERN AUSTRALIA: Eastern end of Yardie Creek, Cape Range National Park, 2 July 2006, *J. English* 58; Cape Range – Charles Knife Rd, 30 Aug. 1960, *A.S. George* 1328; NW Cape - Lighthouse Hill, 31 Aug. 1960, *A.S. George* 1365; Cape Range Peninsula, small creek 5 km S of Exmouth, 2 Oct. 1995, *S. Hunger & N. Kilian* 4195; *c*. 4 miles [6 km] E of Ningaloo Station Homestead, 4 Sep. 1970, *A.S. George* 10222; Pilgonaman Creek, 67 km from Exmouth, on Yardie Creek Rd, Cape Range National Park, 26 July 1980, *K.F. Kenneally* 7308; Minilya–Exmouth Rd near Gales Bay, 6 July 2008, *K.R. Thiele* 3558.

Phenology. Flowers from May to November, with a peak in July.

Distribution and habitat. Restricted to Cape Range between North West Cape and Ningaloo Station (Figure 3), on red loams and sands over limestone, often in watercourses, in *Acacia* shrublands, low open mallee and *Triodia* grasslands.

Conservation status. Common in its restricted area of distribution and not considered to be at risk in

the short term, although its occurrence in an arid environment indicates that it is likely to be adversely affected by climate change.

Etymology. From the Latin 'of the Cape' in reference to the disjunct distribution on North West Cape.

Notes. *Hibbertia capensis* is the only *Hibbertia* species found in the semi-arid Cape Range and is widely disjunct from all other species. It shares a limestone habitat with *H. leptotheca* and *H. spicata*; the former differs in having glabrous outer sepals and longer, narrower anthers, while the latter has more flowers in the cincinnus and long, simple hairs on the cincinnus bracts and sepals. Leaves of *H. capensis* have very strongly recurved margins tightly abutting the midrib and entirely obscuring the abaxial leaf lamina. It is often necessary to break leaves to see the stellate lamina pubescence.

A specimen from Charles Gardner Flora Reserve near Tammin (*R.D. Royce* 8377) closely matches *H. capensis* in leaves and in its sepal indumentum, and does not match *H. polystachya*, which occurs in the area, or the other widespread species *H. prolata*. Unless matching material from the locality is found and assigned to a taxon, it is most likely that the sheet is mis-labelled.

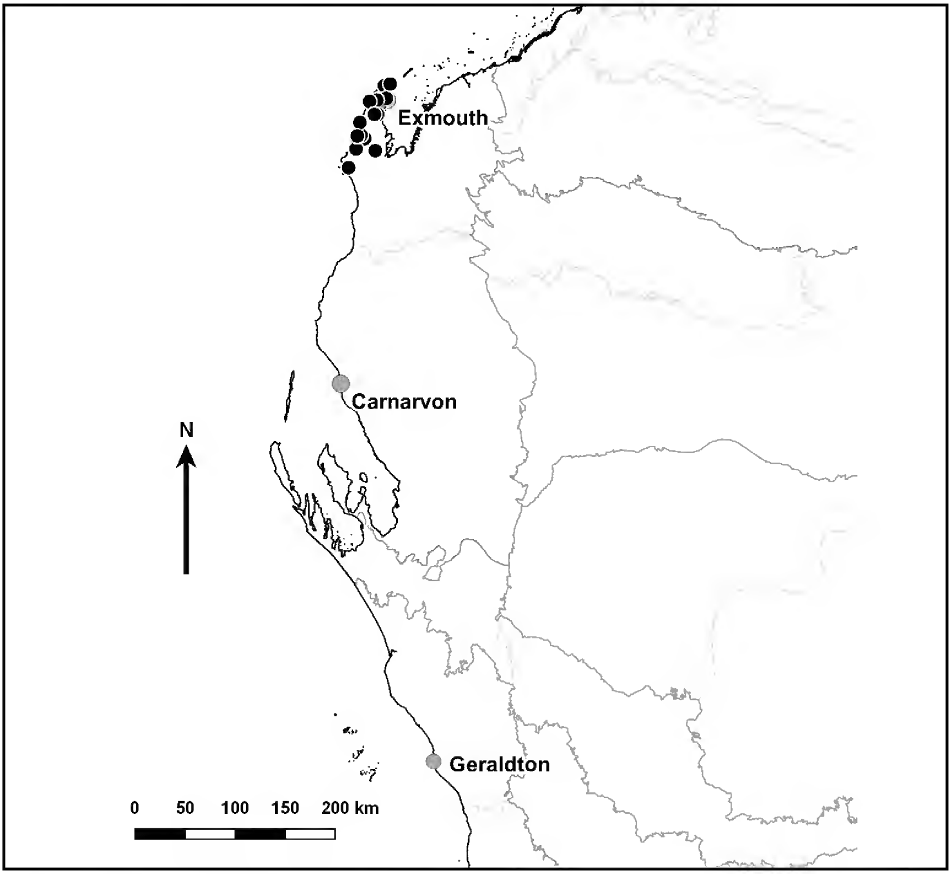

Figure 3. Distribution of *Hibbertia capensis*.

3. Hibbertia subglabra K.R.Thiele, *sp. nov.*

Type: Coorow–Green Head Road, Western Australia [Precise locality withheld for conservation reasons], 7 September 2019, *K.R. Thiele* 5565 (*holo*: PERTH 09085130; *iso*: AD, CANB).

Erect, dwarf *shrubs* to 0.3(–0.5) m high, multi-stemmed at base and resprouting from the rootstock after fire; young stems glabrous except for prominent hair-tufts in the axils; older stems with smooth, papery, silvery bark decorticating in flakes and strips. *Leaves* erect to spreading, scattered, linear, 12–30(–40) mm long, (0.6–)1–2(–3) mm wide; margins loosely revolute, the abaxial lamina usually exposed; adaxial lamina glabrous except at the very base above the axil, smooth to finely scattered-tuberculate; abaxial lamina and midrib glabrous; apex acute, straight to slightly upturned. *Inflorescences* comprising 2–6-flowered cincinni, the lowermost flowers usually well-separated; cincinna axis glabrous or sparsely simple-hairy; bracts ±homomorphic, ovate to triangular, the lowermost 2–3.5 mm long, 0.8–1 mm wide, sparsely hairy as for the sepals. *Sepals* broadly ovate, 3–6 mm long, abaxially with sparse, long, sub-appressed to spreading hairs that are simple or sub-stellate and straight or hooked at the apex; midribs not prominent; outer sepals obtuse; inner sepals similar to the outer but smaller, broader and with fewer hairs, minutely stellate-hairy where covered by the outer. *Petals* yellow, broadly obovate, 8–10 mm long, shallowly to deeply emarginate. *Stamens* 9 or 10, all on one side of the gynoecium, shortly fused by their filaments; anthers oblong, 1.5–1.8 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* 5–7, linear-flattened, behind and lateral to the stamens. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, 1.4–1.8 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen.

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the glabrous abaxial leaf lamina.

Other specimens examined (all PERTH). WESTERN AUSTRALIA: [localities withheld for conservation reasons] 19 Sep. 1983, *R.J. Cranfield* 4266; 15 Oct. 1946, *C.A. Gardner* 8430; 5 Sep. 1976, *E.A. Griffin* 1006; 18 Sep. 1979, *E.A. Griffin* 2274; 10 Sept. 1999, *J.W. Horn* 2366; 3 Oct. 1972, *B.R. Maslin* 3040; 4 Sep. 1984, *J.R. Wheeler* 2343.

Distribution and habitat. Restricted to a relatively small area between Cockleshell Gully and Eneabba (Figure 4). A disjunct occurrence near Mogumber (*R.J. Cranfield* 4266) may be an erroneous location; searches at the locality have failed to reveal any plants of *H. subglabra*. Occurs in sand over laterite on slopes and in gullies, in kwongan heath with scattered eucalypts.

Conservation status. Range-restricted and known from only seven specimens, some of which occur in conservation reserves. To be listed as Priority Three under Conservation Codes for Western Australian Flora (Smith & Jones 2018).

Etymology. From the Latin *glaber* (hairless) with the prefix *sub-* (under, beneath), in reference to the leaves that are abaxially glabrous.

Notes. *Hibbertia subglabra* is distinctive in its glabrous abaxial leaf lamina, all other species in the group being densely stellate-pubescent (except on the midrib). Specimens of all species often have the leaf margins strongly recurved and abutting the midrib, thus obscuring the abaxial lamina; in these cases, care must be taken to find leaves with less strongly recurved margins or that were folded on pressing to expose the abaxial lamina. Occasionally it is necessary to break a leaf to expose the lamina.

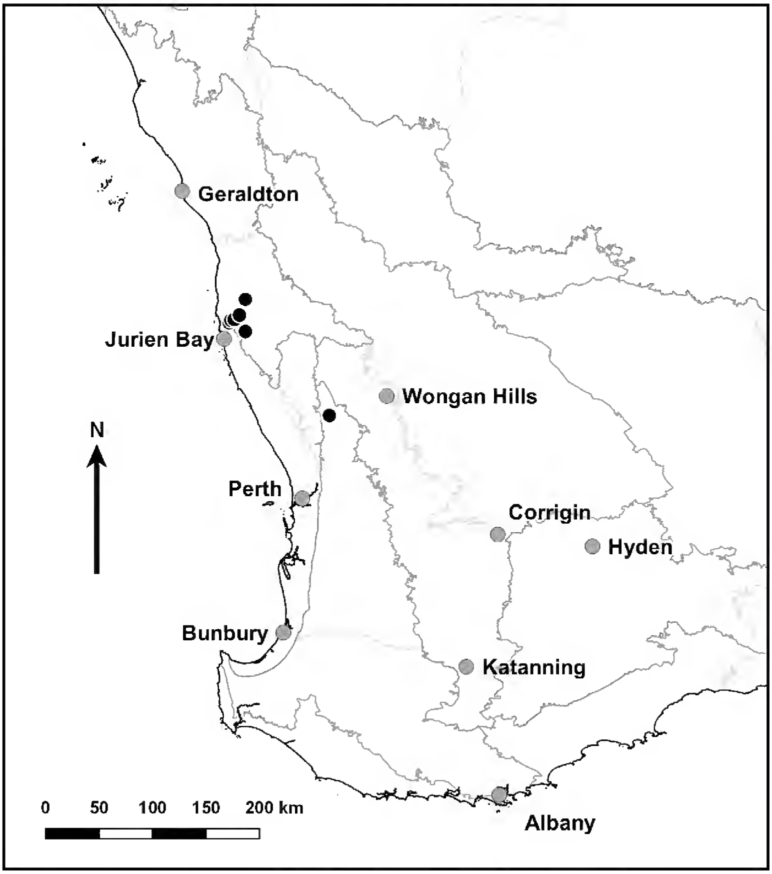

Figure 4. Distribution of *Hibbertia subglabra*.

This species often has unusually long, slender leaves compared with e.g. *H. prolata*.

One specimen of *H. prolata* (*J. Liddelow* 228) also has a glabrous abaxial lamina; however, in all other respects it is typical of its species and cannot be confused with specimens of *H. subglabra*.

4. Hibbertia spicata F.Muell, *Fragm. (Mueller)* 2(11): 1 (1860). *Type citation*: 'Ad portum Gregorii [Port Gregory]. Walcott et Oldfield.' (*syn*: K 687450 image!; MEL 666907 (fragments)!).

Erect to spreading, compact to open, sometimes dwarfed *shrubs* to 0.7 m high, multi-stemmed at base and resprouting from the rootstock after fire; young stems minutely and sparsely stellate-pubescent at first, soon glabrous; older stems with grey, fissured, papery bark. *Leaves* erect to spreading, scattered, linear, 12–25(–35) mm long, 1.2–2(–4) mm wide; margins revolute, the abaxial lamina hidden or exposed; adaxial lamina glabrous, scattered-tuberculate; abaxial lamina densely stellate-pubescent, the midrib glabrous; apex obtuse to sub-acute. *Inflorescences* comprising (6–)8–14-flowered cincinni, all flowers close and overlapping; cincinna axis sparsely stellate-pubescent; bracts heteromorphic, each flower (except the lowermost) subtended by a narrowly obovate-spathulate bract 3–4.5 mm long, 0.8–2 mm wide and a broadly ovate bract 3.5–7 mm long, 2.5–3 mm wide, the bracts sparsely hispid with hairs often restricted to the margins. *Sepals* ovate, 5–7 mm long, abaxially sparsely pubescent to

hispid with stellate or simple hairs especially along the midline; midribs not to moderately prominent; outer sepals obtuse; inner sepals similar to the outer but broader and with fewer or no simple hairs. *Petals* yellow, broadly obovate, 7.5–8 mm long, shallowly to deeply emarginate. *Stamens* 6(7), all on one side of the gynoecium, shortly fused by their filaments; anthers oblong, 1.5–1.7 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* 10–14, short and broadly flattened, all around the gynoecium. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, 2–2.5 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen.

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the cincinnus comprising 6–14 flowers, each flower (except the lowermost) subtended by two distinctly heteromorphic bracts, one broad and one narrow.

Selected specimens (all PERTH). WESTERN AUSTRALIA: Greenough Rd near Greenough River, 18 Aug. 2008, *L. Atkins* Sp 317; Spalding Park, 3 miles [5 km] N of Geraldton, 30 Aug. 1965, *A.C. Burns* 17; Horrocks Rd, 500 m from beach, 7 July 1997, *R. Davis* 3587; 20 km S of Kalbarri National Park boundary on Grey Rd, 7 Sep. 1997, *S. Donaldson & G. Flowers* SD1496; 2 miles [3 km] S of Red Bluff, 4 Sep. 1963, *A.R. Fairall* 1226; 60.4 km W along State Barrier Fence Access track from NW Coastal Hwy, 26 Aug. 1994, *G.J. Keighery & N. Gibson* 1349; Horrocks, 27 Aug. 1983, *C.M. Lynch* 154; Pot Alley Gorge, Kalbarri National Park, 26 Sep. 1974, *G. Perry* 301; Shark Bay, 29 Sep. 1989, *M.E. Trudgen* 7400; Chapman River Regional Park, Geraldton, 2 June 1999, *S. Vigilante* 61; Red Bluff, Kalbarri, 6 Sep. 1984, *J.R. Wheeler* 2375.

Phenology. Flowers from April to October, with a peak in early September.

Distribution and habitat. Occurs on coastal limestones from Geraldton to the southern end of Shark Bay (Figure 5). A few specimens have been recorded from coastal sandstone bluffs (e.g. Red Bluff) close to limestone. Grows in sandy and clay soils, in coastal heathlands, shrublands and low woodlands.

Conservation status. Relatively widely distributed including in several national parks and nature reserves, and not considered to be at risk.

Notes. Specimens of *H. spicata* are immediately recognisable by the many-flowered cincinni with the flowers and bract overlapping, giving a distinctively crowded appearance. In all other species the flowers are fewer and more widely-spaced (*H. capensis* sometimes also has overlapping flowers in the cincinnus). The cincinnus bracts in *H. spicata* are also distinctively heteromorphic. One bract is obliquely inserted on the cincinnus axis and is large and broad, while the other is transversely inserted and is much narrower.

5. Hibbertia leptotheca (J.R.Wheeler) K.R.Thiele, *comb. et stat. nov.*

Hibbertia spicata Benth. subsp. *leptotheca* J.R.Wheeler, *Nuytsia* 5(1): 35–37 (1984). *Type*: Yalgorup National Park, between the north end of Lake Preston and Martin's Tank Lake, Western Australia, 17 September 1981, *N.G. Marchant* 81/76 (*holo*: PERTH 1627198!; *iso*: CANB 363019 *n.v.*, MEL 677577!).

Small, spreading *shrubs* to 0.3 m high; young stems glabrous, multi-stemmed at base and resprouting from the rootstock after fire; older stems with grey, papery-fissured bark. *Leaves* spreading, scattered,

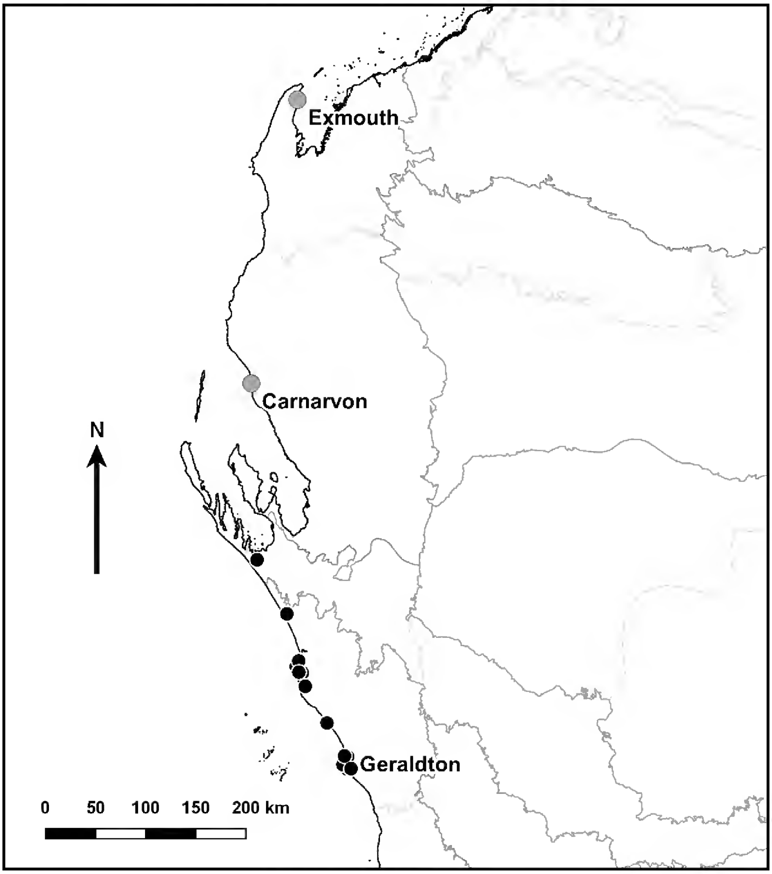

Figure 5. Distribution of *Hibbertia spicata*.

linear, (8–)12–25(–35) mm long, 0.8–1 mm wide; margins revolute and hiding the abaxial lamina or nearly so; adaxial lamina glabrous, smooth to rarely sparsely scattered-tuberculate; abaxial lamina where visible densely stellate-pubescent, the midrib glabrous; apex acute. *Inflorescences* comprising 2–5-flowered cincinni, the flowers well-separated; cincinna axis glabrous; bracts ±homomorphic, linear to narrowly obovate, 2–4 mm long, 0.8-1.5 mm wide, glabrous. *Sepals* ovate, 3.5–5 mm long, the outermost abaxially glabrous; midribs not prominent; outer sepals broadly acute; inner sepals similar to the outer but broader, more obtuse, glabrous or finely and sparsely minutely stellate-pubescent. *Petals* yellow, broadly obovate, 5–6 mm long, shallowly to deeply emarginate. *Stamens* (8–)10–12(–15), all on one side of the gynoecium, shortly fused by their filaments; anthers linear, 1.8–2.8 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* 0(–3), when present lateral to or behind the stamens. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, 2–2.5 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen.

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the glabrous outer sepals and long, narrow anthers.

Selected specimens (all PERTH). WESTERN AUSTRALIA: [localities withheld for conservation reasons] 20 Sep. 2003, *P. Foreman* 391; 8 Dec. 1992, *E.A. Griffin* 8401; 1 Sep. 1897, *R. Helms s.n.*

(PERTH 2625482); 21 Sep. 1990, *G.J. Keighery* 11492; 14 Sep. 1995, *G.J. Keighery* 14093; 25 Oct. 1982, *J.R. Wheeler* 2040; 27 Aug. 1957, *C.L. Wilson* 870.

Phenology. Flowers between August and October, with a peak in September.

Distribution and habitat. Occurs in coastal and near-coastal sites from west of Cataby south to Lake Preston (Figure 6), growing in sand over limestone in coastal heaths and thickets usually dominated by species of *Melaleuca* and *Acacia*.

Conservation status. Listed as Priority Three under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *H. spicata* subsp. *leptotheca*.

Notes. Wheeler (1984) described *H. leptotheca* as a subspecies of *H. spicata s.l.* She presumably used subspecies rank due to the wide variation she perceived in the latter, and because elsewhere in its range *H. spicata s.l.* shares a limestone habitat with *H. leptotheca* (i.e. the species segregated here as *H. capensis* and *H. spicata s.s.*). However, it is clearly separate both geographically and morphologically from other taxa in the group, with no intermediates, and constitutes a separately evolving lineage. I regard that species rank is appropriate for this taxon.

6. Hibbertia prolata K.R.Thiele, *nom. nov.*

Hemistephus linearis J.Drumm. ex Harv., in Hooker, W.J. (ed.), *Hooker's Journal of Botany and Kew Garden Miscellany* 7: 52 (1855); *Hemistemma lineare* (J.Drumm. ex Harv.) F.Muell., *Fragm. (Mueller)* 1(7): 162 (1859). *Type citation*: 'Northern Districts.' (*syn*: TCD 9690 image!, MEL 666664!).

Dense to open, often rounded, erect to spreading *shrubs* to 0.8 m high, multi-stemmed at base and resprouting from the rootstock after fire; young stems glabrous to sparsely stellate-pubescent with minute hairs, soon glabrous; older stems with grey, papery, fissured bark. *Leaves* erect to spreading, scattered, linear to very narrowly obovate, (10–)12–25(–30) mm long, 0.8–2 mm wide; margins revolute and usually hiding the abaxial lamina or nearly so; adaxial lamina glabrous, scattered-tuberculate; abaxial lamina densely stellate-pubescent, the midrib glabrous; apex acute, sometimes bluntly so. *Inflorescences* comprising (1–)2–5(–7)-flowered cincinni, the flowers well-separated; cincinna axis glabrous to sparsely stellate-pubescent; bracts ±homomorphic, linear to narrowly obovate, 2–3.5(–5) mm long, 0.5–1.5 mm wide. *Sepals* ovate, 5–6 mm long, abaxially with few to many, spreading to retrorse, hooked hairs mostly towards the base, sometimes underlain by sparse stellate hairs; midribs prominent; outer sepals acute; inner sepals broader and thinner-textured than the outer, with sparser hooked hairs. *Petals* yellow, broadly obovate, 6–8.5 mm long, shallowly to deeply emarginate. *Stamens* 10(–12), all on one side of the gynoecium, shortly fused by their filaments; anthers oblong, 1.2–1.8 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* present, 6–20, behind, lateral to and/or opposite the stamens. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, *c.* 1.5 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen. (Figure 1B)

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the leaf lamina that is adaxially glabrous and abaxially densely stellate-pubescent, and the outer sepals with few to many hooked hairs.

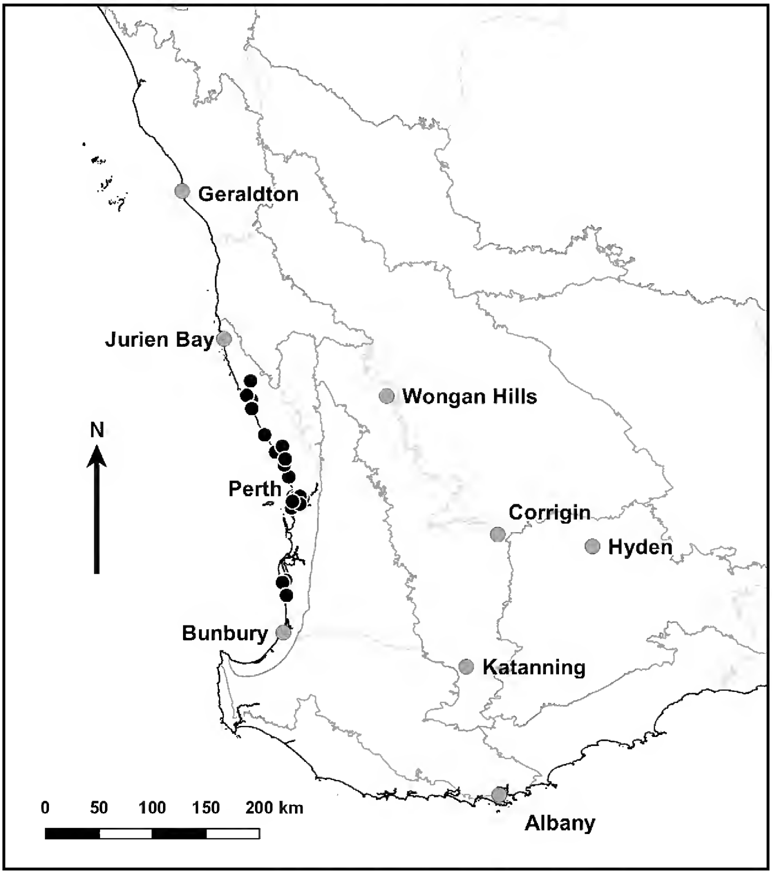

Figure 6. Distribution of *Hibbertia leptotheca*.

Selected specimens (all PERTH). WESTERN AUSTRALIA: Dingo Hill, 5 km along First North Rd from Eneabba-Three Springs Rd, 11 Oct. 2003, *J. Borger* BB212; junction of Cape Naturaliste Rd and Bunker Bay Rd, Dunsborough, 13 Oct. 2008, *H. Cole* 744; 3 km E of Woodanilling, 3 Nov. 1978, *R.J. Cranfield s.n.*; behind Gillingarra School, 6 Oct. 2006, *C. Danese & D. Rayner* BK 1006-06; Greenough River, 1 km W of the first railway crossing on Geraldton-Mullewa Rd, 55 km W of Mullewa, 20 Oct. 1983, *S.J. Forbes* 1714; Wagin, 26 Oct. 1920, *C.A. Gardner* 1003; Avondale Research Station, 6 km W of Beverley, 22 Oct. 1979, *R.J. Hnatiuk* 790181; near The Casuarinas (*c.* 36 miles [58 km] E of Geraldton), 18 Sep. 1971, *R.D. Hoogland* 11982; along North West Coastal Hwy S of Ajana-Kalbarri turn-off, near mile peg 369, 20 Sep. 1971, *R.D. Hoogland* 11996; S side of Eneabba-Three Springs Rd, 6.4 km W of its junction with Reserve Rd, 25 Aug. 2001, *J.W. Horn* 4008; Benn Reserve, 1 km NW of Kojonup, 14 Nov. 1999, *C.M. Lewis* 464; Serpentine National Park, about 750 m ESE of Chatfield Rd, 31 Oct. 1996, *A. Markey* 492; Red Hill, 22 Sep. 1944, *R. D. Royce s.n.* (PERTH 3107299); Helena Valley, 26 Sep. 1977, *J. Seabrook* 312; 2 miles [3.5 km] W of Eradu on Mullewa-Geraldton Rd, 1 Oct. 1966, *E.M. Scrymgeour* 1449; Helena Valley, Ridge Rd, 25 Sep. 1981, *J.R. Wheeler* 2013; Jarrahdale Scenic Drive, 2.5 km along Barge Rd from South West Hwy, 5 Oct. 1983, *J.R. Wheeler* 2231; 4.5 km N of Binnu, 6 Sep. 1984, *J.R. Wheeler* 2372; Eagle Bay, Meelup, 7 Sep. 1985, *J.R. Wheeler* 2402.

Phenology. Flowers between June and November, with a peak in September.

Distribution and habitat. Widely distributed from Binnu to Katanning, in the southern part of its range occurring in the far western Wheatbelt and along the Darling Range, with a disjunct population around Cape Naturaliste (Figure 7). A few collections from Jurien Bay and Green Head are close to the coast, but these are not usually on limestone. Mostly found in sandy soils over granite or laterite, in woodlands, mallee, shrublands and heath.

Conservation status. Widespread and common and not considered to be at risk.

Etymology. From the Latin *prolatus* (extended, elongated) in reference to the cincinnus having rather well-separated flowers compared with *H. spicata s.s.*, from which it has been segregated.

Notes. *Hibbertia prolata* is a widespread species. It tends to occur westwards of the range of the other widespread species, *H. polystachya*, but there is substantial overlap.

Most specimens of *H. prolata* have a distinctive sepal indumentum, comprising few to many spreading to retrorse, hooked hairs mostly concentrated towards the sepal base. The only other species in the group with a similar indumentum is *H. subglabra*, which differs in having the abaxial leaf lamina glabrous. The disjunct specimens from near Cape Naturaliste are typical in all other respects. A few specimens (e.g. *R.D. Royce s.n.* PERTH 3107299; *R.J. Hnatiuk* 790181) lack these hairs and appear superficially similar to *H. leptotheca* but can be distinguished from that species by the shorter, less slender anthers.

Seven specimens collected between Gillingarra, Jurien Bay and Arrino lack the hooked hairs and have a denser sepal indumentum of simple, ±appressed hairs. These are provisionally included in *H. prolata* pending further field work.

7. Hibbertia polystachya Benth, *Fl. Austral.* 1: 22–23 (1863). *Type citation*: 'W. Australia. Swan River, Drummond; Blackwood river, Oldfield.' (*syn*: [Oldfield] MEL 666681!; [Drummond] K 687446 image!, K 687447 image!, K 687448 image!, MEL 666680!).

Compact to straggling, often sprawling *shrubs* to 0.3(–0.7) m high, multi-stemmed at base and resprouting from the rootstock after fire; young stems sparsely to moderately stellate-pubescent, sometimes also with scattered simple hairs; older stems with grey, papery bark decorticating in strips. *Leaves* erect to spreading, scattered, narrowly elliptic to linear, 5–20 mm long, 0.8–3 mm wide, the margins revolute with the abaxial lamina usually exposed; adaxial lamina with sparse to abundant, short to long, soft, simple, often tubercle-based hairs, sometimes also with scattered, tubercle-based stellate hairs; abaxial lamina densely stellate-pubescent, the midrib with indumentum as for the adaxial lamina; apex obtuse to subacute. *Inflorescences* comprising (1–)2–5-flowered cincinni, the flowers well-separated; cincinna axis sparsely pubescent with usually long simple hairs, sometimes also with intermixed stellate hairs; bracts ±homomorphic, narrowly ovate to linear, 3–6 mm long, 1–2 mm wide, with indumentum as for the leaves. *Sepals* narrowly ovate to ovate, 7–10 mm long, abaxially pubescent to pilose with long, simple hairs sometimes intermixed with hooked and/or stellate hairs; midribs prominent; outer sepals often leaf-like with recurved margins, acute; inner sepals thinner, broader and less hairy than the outer, with broader (to obtuse) apex. *Petals* yellow, broadly obovate, 7.5–12 mm long, shallowly to deeply emarginate. *Stamens* (6–)10(11), all on one side of the gynoecium, shortly fused by their filaments; anthers oblong, 1.6–2 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* 5–10, mostly lateral to and opposite the stamens (a few sometimes behind the stamens), those opposite sometimes broad and petaloid. *Carpels* 2; ovaries rather rectangular-cuboid, densely pubescent; styles excentric from near the carpel apex, ±straight then slightly curved at the apex, 1.2–1.8 mm long. *Ovules* 2 per carpel. *Fruiting carpels* and seeds not seen.

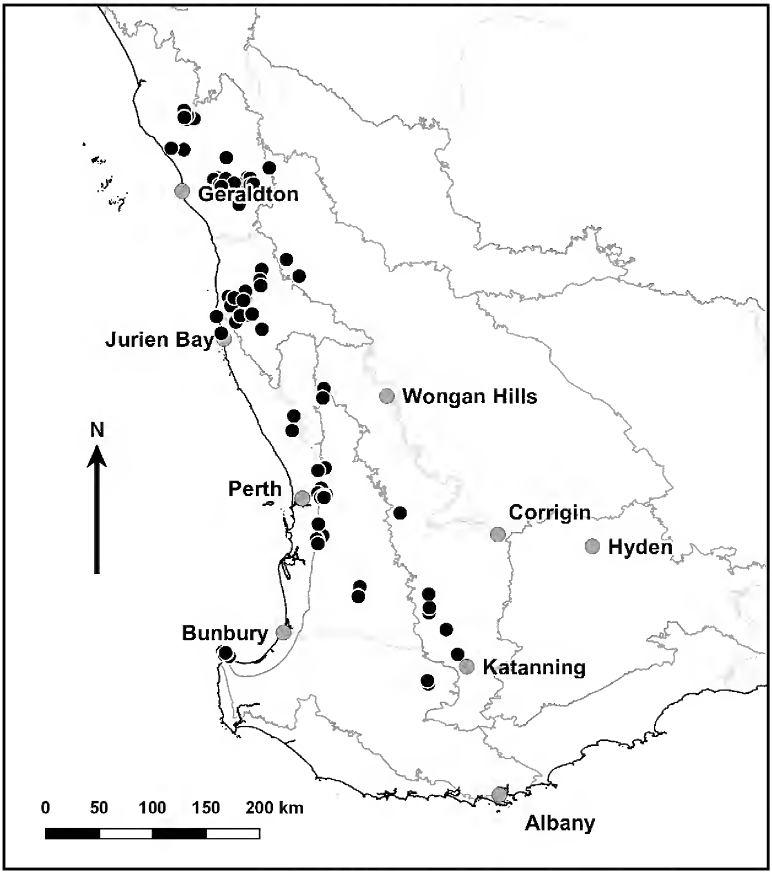

Figure 7. Distribution of *Hibbertia prolata*.

Diagnostic features. May be distinguished from all other species in the *Hibbertia spicata* species group by the adaxial leaf laminas and sepals with sparse to abundant simple hairs.

Selected specimens (all PERTH). WESTERN AUSTRALIA: 11.5 km S of Cachionalgo Hill, off Bindoon-Dewars Pool Rd, 7 Nov. 1996, *M.G. Allen* 303; 5 km NE of Cataby, 28 Oct. 1993, *P. Armstrong s.n.*; 8.5 km NW of Calingiri, 20 Sep. 1983, *R.J. Cranfield* 4339; Dobaderry Rd, 4.6 km N of Dale West Rd intersection, 8 Oct. 1997, *R. Davis* 4256; Bowelling-Duranillin Rd, 2.9 km from Bowelling, 17 Nov. 1997, *R. Davis* 4471; Jingaring Reserve, *c.* 33 km ESE of Brookton, 1 Sep. 1998, *R. Davis* 6526; Wambyn Nature Reserve, 9 Oct. 1998, *R. Davis* 7148; N end of Corry Rd, W of Corrigin, 24 Sep. 2007, *M. Hislop & H. Mills* WW 209-38; Along main road from Gingin to Dongara at crossing with Mullering Brook, 15 Sep. 1971, *R.D. Hoogland* 11969; Brand Hwy, 2.3 km S of its junction with Yandin Rd, 22 Aug. 2001, *J.W. Horn* 4000; Kondinin-Narembeen Rd, 220 m S of Billericay-East Rd, 24 Sep. 1997, *G.J. Keighery & N. Gibson* 3715; Narlingup Reserve, 28 km W of Kojonup, 17 Oct. 1997, *C.M. Lewis* 300; Stirling Rd, 25 km WNW of Kojonup, 5 Nov. 2000, *C.M. Lewis* 486; Airstrip Rd, 0.3 km from intersection of Jilakin Rd, 21 Oct. 2001, *S. Murray* 525; 73 km from Perth along main road to Brookton, by Christmas Tree Well, 27 Oct. 1982, *A. Strid* 21108; Chittering Valley Rd 35.8 km from Bullsbrook towards Bindoon, 5 Sep. 1982, *J.R. Wheeler* 2034; Dumbleyung-Lake Grace Rd, 17 km E of Dumbleyung, 21 Sep. 1986, *J.R. Wheeler* 2405; junction [of] Talbot West Rd and Talbot Rd, 9 Oct. 2001, *J.R. Wheeler* 4129; Beekeepers Reserve, 18 Sep. 1985, *R.T. Wills* 110.

Phenology. Flowers between August and December, with a peak in October.

Distribution and habitat. Widely distributed in the Western Australian wheatbelt and Darling Range from east of Mingenew to Katanning and west to near Kojonup, generally inland from the coast (Figure 8). Occurs on sandy, loamy and clay soils generally over granite or laterite, in wandoo woodlands, *Acacia* and *Allocasuarina* shrublands, mallee, and heathlands.

Conservation status. *Hibbertia polystachya* is widely distributed and common and is not considered to be at risk.

Notes. *Hibbertia polystachya* is more widespread and variable in leaf, cincinnus and sepal indumentum than any other species in the *H. spicata*–*H. polystachya* group. It tends to occur inland (east) of the other widespread taxon, *H. prolata*, although there is substantial overlap. Indumentum varies from sparsely pubescent with short, straight simple hairs arising from prominent tubercles to villous with long, soft, silky hairs without distinct tubercles. There may also be varying development of short stellate hairs interspersed with the simple ones. The variation, however, is continuous and, although there is a tendency for villous specimens to be at the western edge of the range, not geographically partitioned.

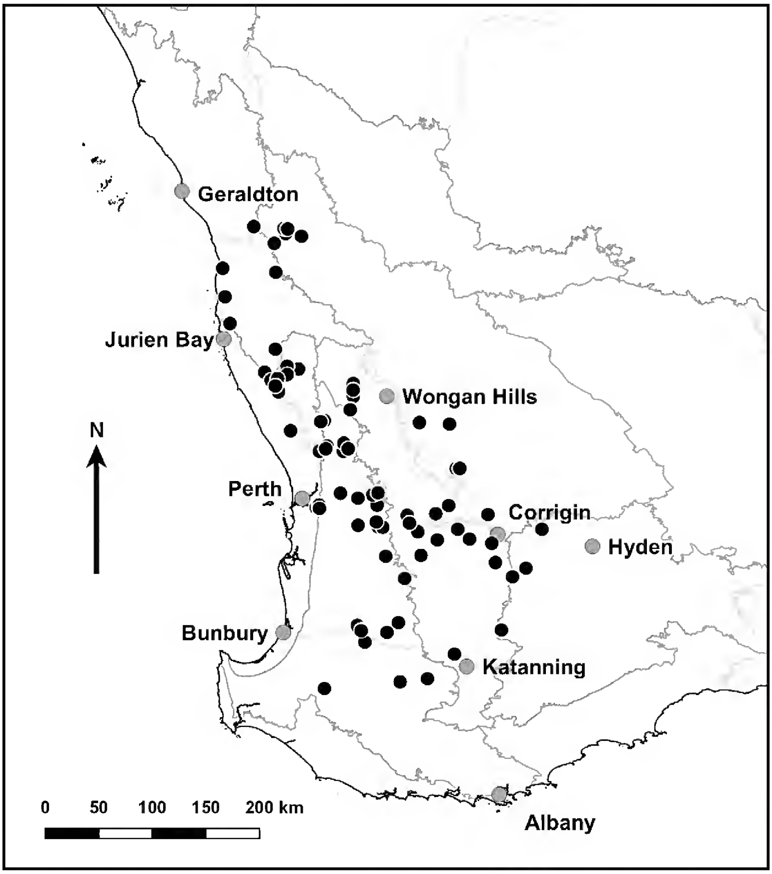

Figure 8. Distribution of *Hibbertia polystachya*.

In almost every case, specimens of *H. polystachya* may be distinguished from *H. prolata* by the presence of simple hairs on the adaxial leaf surface at least on young leaves. Leaves in *H. prolata* are adaxially glabrous.

One specimen (*J. Liddelow* 228) from near Lake Muir is unusual in having a glabrous abaxial leaf lamina (as for *H. subglabra*). However, it is typical for *H. polystachya* in all other respects, with simple-hairy adaxial leaf lamina and abaxial midrib, and typical sepal indumentum.

There are four Drummond specimens of *H. polystachya*, three at K and one at MEL, annotated variously as *Drummond* 15, *Drummond* 12, *Drummond* 17 and Drummond *s.n.*. All appear to be separate gatherings based on differences in leaf and sepal indumentum, and all fall within the range of variation of *H. polystachya* in these characters. Given that Bentham did not specify a Drummond number in the protologue for *H. polystachya*, all are here regarded as syntypes. I choose not to lectotypify as no benefit is to be gained by doing so at this time and I prefer to leave lectotypification as an option for future workers if the need arises.

Summary of taxon circumscriptions

Hibbertia polystachya Benth. in this paper has the same circumscription as *H. polystachya* Benth. as previously accepted at PERTH.

Hibbertia spicata F.Muell. in this paper has a narrower circumscription than *H. spicata* F.Muell. subsp. *spicata* as previously accepted at PERTH due to the removal of *H. asterella* K.R.Thiele, *H. subglabra* K.R.Thiele, *H. capensis* K.R.Thiele and *H. prolata* K.R.Thiele.

Hibbertia asterella K.R.Thiele *sp. nov.* in this paper is removed from *H. spicata* F. Muell. subsp. *spicata* as previously accepted at PERTH.

Hibbertia subglabra K.R.Thiele *sp. nov.* in this paper is a new taxon and is removed from *H. spicata* F. Muell. subsp. *spicata* as previously accepted at PERTH.

Hibbertia capensis K.R.Thiele *sp. nov.* in this paper is a new taxon and is removed from *H. spicata* F. Muell. subsp. *spicata* as previously accepted at PERTH.

Hibbertia prolata K.R.Thiele *nom. nov.* in this paper is removed from *H. spicata* F.Muell. subsp. *spicata* as previously accepted at PERTH.

Hibbertia leptotheca (J.R.Wheeler) K.R.Thiele *comb. et stat. nov.* in this paper has the same circumscription as *H. spicata* subsp. *leptotheca* as previously accepted at PERTH.

Acknowledgements

I thank the staff of the Western Australian Herbarium (PERTH) and National Herbarium of Victoria (MEL) for access to their collections.

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30: 309–316 Published online 10 December 2019

A new name, clarification of synonymy, and a new subspecies for *Isopogon* (Proteaceae) in Western Australia

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Abstract

Rye, B.L. & Macfarlane, T.D. A new name, clarification of synonymy, and a new subspecies for *Isopogon* (Proteaceae) in Western Australia. *Nuytsia* 30: 309–316 (2019). *Isopogon drummondii* Benth. *nom. illeg.* is lectotypified and replaced by the new name *I. autumnalis* Rye & T.Macfarlane while *I. drummondii* Hügel ex Jacques is recognised as a probable synonym of *I. sphaerocephalus* Lindl. The new subspecies *I. sphaerocephalus* subsp. *lesueurensis* Rye is described.

Introduction

This paper undertakes to settle the uncertainty around the name of a Western Australian species of *Isopogon* R.Br. (Proteaceae), the solution to which involves a second species, in which a new subspecies is recognised.

In his treatment of *Isopogon* for the *Flora of Australia*, Foreman (1995) described one species as *I.* sp. A because he was uncertain whether the name *I. drummondii* Hügel ex Jacques (Jacques 1843) applied to it. A later-published name with the same epithet, *I. drummondii* Benth. (Bentham 1870), does apply to Foreman's species A but cannot be used because it is an illegitimate later homonym.

The name *I. drummondii* Hügel ex Jacques was not mentioned by Bentham (1870), possibly because it was published in a horticultural context. It was based on cultivated plants with no precise locality of origin, has no illustration and evidently lacks a type, problems commonly encountered among Jacques's names. The protologue does not give any information regarding the flowers and fruits of the species but does provide a moderately detailed description of its leaves. Whereas Jacques's species was described as having linear leaves 6–15 cm (i.e. 60–150 mm) long, Bentham's species has terete leaves 20–65 mm long. This difference alone is sufficient to show that they are distinct entities, so *I. drummondii* Benth. needs to be replaced by a new, legitimate name. The new name chosen here is *I. autumnalis* Rye & T.Macfarlane.

A far more likely match for *I. drummondii* Hügel ex Jacques in leaf morphology is *I. sphaerocephalus* Lindl., an attractive species that was collected by James Drummond during the early stages of settlement of the Swan River area of Western Australia. It has a moderately large range from near Gidgegannup to the south coast, with an isolated, distinctive variant occurring much further north near Mt Lesueur. This northern variant is named here as subsp. *lesueurensis* Rye.

https://florabase.dpaw.wa.gov.au/nuytsia/

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Taxonomy

Isopogon autumnalis Rye & T.Macfarlane, *nom. nov.*

Isopogon drummondii Benth., *Fl. Austral.* 5: 344–345 (1870), *nom. illeg.*; *Atylus drummondii* (Benth.) Kuntz, *Revis. Gen.* 2: 577 (1891). *Type citation*: 'Swan River, *Drummond*, 1*st coll.*, *Preiss*'. *Type specimens*: Swan River [Western Australia], 1839, *J. Drummond* 1st coll., *s.n.* (*lecto*, here designated: K 000736646 image!; *isolecto*: BM 000991907 image!, K 000736645 image!); Swan River [Western Australia], *s. loc.*, *J.A.L. Preiss s.n.* (*syn*: MEL 1531863 image!).

Isopogon sp. A; D.B. Foreman, *Fl. Australia* 16: 204 (1995).

[*Isopogon drummondii auct. non* Hügel ex Jacques: Council of Heads of Australasian Herbaria, *Australian Plant Census*, https://biodiversity.org.au/nsl/services/APC (2006–2019); *FloraBase*, https://florabase.dpaw.wa.gov.au/ (2006–2019).]

[*Isopogon petrophiloides auct. non* R.Br.: C.F. Meissner in J.G.C. Lehmann, *Pl. Preiss* 1: 503 (1845).]

Illustrations. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildflowers* 1: 146 (1988) [as *Isopogon drummondii*]; D.B. Foreman, *Fl. Australia* 16: 206, fig. 100 (1995) [as *Isopogon* sp. A].

Shrubs 0.3–1 m high, commonly 0.5–1 m wide, lignotuberous. *Young stems* with a very dense, short indumentum of whitish, coiled hairs and also with patent hairs 0.4–0.7 mm long. *Leaves* mostly curved, simple, (20–)30–50(–65) mm long, 1.3–2.1 mm wide, broadest towards the apex, terete and glabrous except for the base, mucronate; petiole or flattened base *c.* 4 mm long, densely coiled-hairy on abaxial surface and sometimes on basal part of adaxial surface; mucro erect, stout, *c.* 1 mm long, pale at first but usually with a dark tip, becoming dark. *Flower heads* solitary, terminal, erect, very broadly or depressed ovoid and 20–35 mm diam. when in full flower (often smaller and broadly ovoid in bud and fruit), with numerous, densely packed involucral and floral bracts and closely surrounded by leaves; bracts very densely hairy outside with long whitish hairs, sometimes with a short, dark, glabrous tip. *Tepals* usually 10–12 mm long, pale yellow; claw covered throughout by widely spreading wavy (curved or loosely curled), silky hairs, separating to just below the base of the pollen presenter, which extends slightly below the base of the limb; limb 3.5–4 mm long, usually ciliate in lower part, with a terminal tuft of hairs 0.3–0.6 mm long, the four parts of the limb becoming curved after separating from one another. *Anthers* 2.3–2.5 mm long including terminal appendage; connective appendage 0.45–0.5 mm long, becoming dark. *Pollen presenter* 3–3.5 mm long, densely and minutely papillose-hairy on the pedestal and swelling, with a slight to obvious constriction separating the pedestal from the much shorter swelling; pedestal slightly to distinctly shorter than the receptor; swelling *c.* 0.3 mm wide; receptor 1.5–2.3 mm long, lacking papillae or with papillae restricted to the base. *Cones* very broadly ovoid; involucral bracts similar to cone scales. *Cone scales* spathulate, up to *c.* 10 mm long, with margin incurved; outer surface very densely villous; inner surface glabrous or sparsely hairy. *Diaspores* ovoid, 5–5.5 mm long, 2.3–2.5 mm diam.; largest hairs widely spreading (with some directed downwards), *c.* 5 mm long; mature seed not seen.

Diagnostic characters. Distinguished from all other members of the genus in having the following combination of characters: simple, terete leaves and pale yellow flowers.

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]:

23 July 2001, *F. Hort* 1322 (PERTH); 26 Feb. 2003, *G.J. Keighery* 16418 (PERTH); 8 June 2006, *M. Morley & V. English* JP 1 (PERTH); 27 Apr. 2013, *K.R. Thiele* 4767 (PERTH).

Distribution and habitat. Occurs in sandy soils, often in *Banksia* woodlands, near the west coast of southern Western Australia in the Geraldton Sandplains, Jarrah Forest and Swan Coastal Plain bioregions. The distribution extends from Cockleshell Gully (north-east of Jurien Bay) south to Serpentine (Figure 1A).

Phenology. Flowers recorded primarily in the first half of the year, especially from February to May, and mature fruits recorded from March to May.

Conservation status. Currently listed as Priority Three under Conservation Codes for Western Australian Flora (Smith & Jones 2018). This species appears to be susceptible to dieback.

Etymology. From the Latin adjective *autumnalis* (autumnal) to reflect the species' unusual flowering period, which peaks in autumn. Most other species of *Isopogon* have their main flowering time in spring.

Vernacular name. Autumn Isopogon.

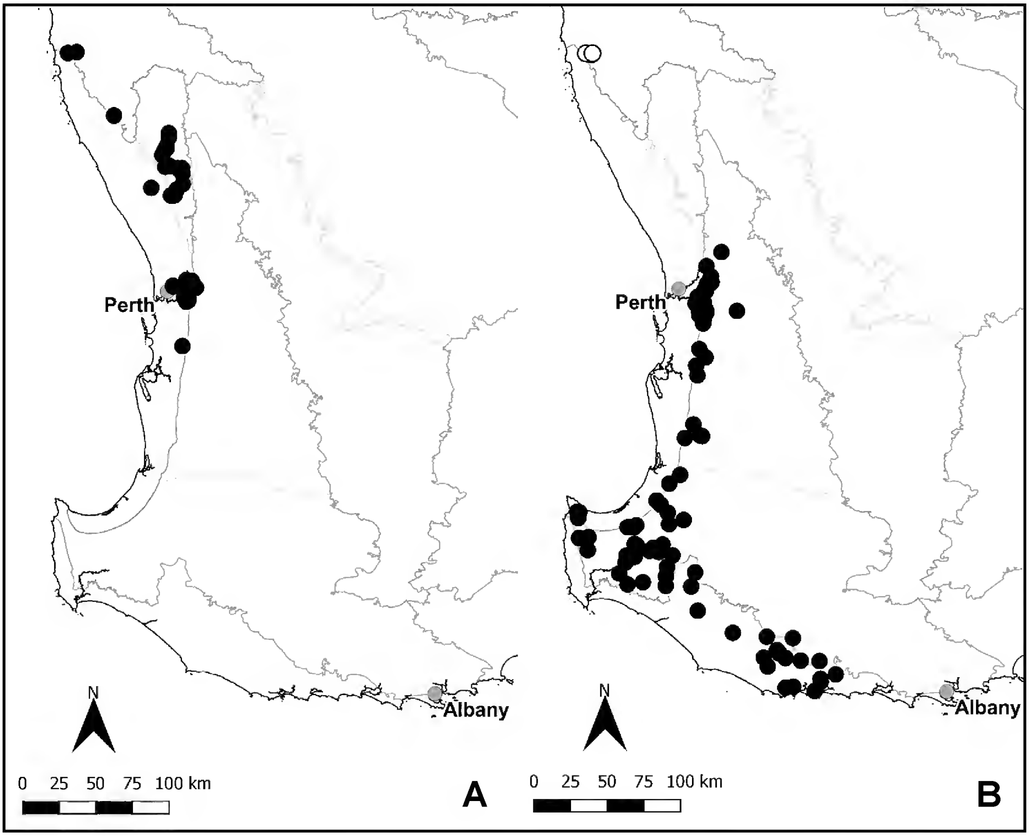

Figure 1. Distribution maps. A – *Isopogon autumnalis* (●); B – *I. sphaerocephalus* subsp. *lesueurensis* (○) and subsp. *sphaerocephalus* (●).

Affinities. This species seems very distinctive. It was placed in sequence between *I. longifolius* R.Br. and *I. villosus* Meisn. by Foreman (1995) but is unlikely to be confused with either of those species and its closest affinities are uncertain.

Typification. Foreman (1995: 204) listed Kew material of the Drummond syntype, which he had examined and confirmed as type material of *I. drummondii* on 12 January 1994, but did not list any material of the Preiss syntype. Three specimens of the *J. Drummond s.n.* syntype currently have images on *Global Plants*, two from the same Kew sheet annotated by Bentham and Foreman, and the other from the Natural History Museum (BM), but none of the Preiss syntype. A Preiss specimen that bears the "B" annotation indicating that it was seen by Bentham has been located at MEL (1531863); this specimen, is consistent with the syntype citation in lacking collection details,

We have selected one of the Drummond specimens, K 000736646, as the lectotype because it has two inflorescences and the date 1839, which accords well with the attribution to Drummond's first collection. The other specimen on the same sheet, K 000736645, is from Hooker's herbarium but has only one inflorescence and no date indicated, while the BM 000991907 specimen is not annotated by Bentham. The Preiss syntype at MEL was not chosen because it is in a poorer physical condition.

In the protologue for *I. drummondii* Benth., Bentham (1870: 345) lists the synonymy as '*I. petrophiloides*, Meissn. in Pl. Preiss. i. 503, and in DC. Prod. xiv. 276, partly, but not of Br.', and notes 'The foliage of the species is nearly that of the undivided states of *I. teretifolia* and *I. scabriuscula*, with the former of which (the *I. petraphiloides*, Br.) it may have been confounded by Meissner, as he quotes Baxter's specimens as well as Drummond's and Preiss's.' This note refers to a partial misapplication by Meisner (1845, 1856) of the name *I. petrophiloides* R.Br. to Bentham's new species *I. drummondii* Benth. in regard to Meisner's citation of two numbered Preiss specimens (679, 680) and an un-numbered Drummond first collection specimen. These are all represented in the de Candolle *Prodromus* herbarium at Geneva (G-DC; International Documentation Centre 1962). It is possible that the un-numbered Preiss syntype at MEL is a duplicate of one of the numbered specimens cited by Meisner under *I. petrophiloides*, but evidently its number had been lost before Bentham saw it.

Notes. A description of *I. autumnalis* [as *I. drummondii* Benth.] was given in the *Flora of the Perth Region* (Rye 1987). Later, the species was treated for some time as *I. drummondii* Hügel ex Jacques. See the discussion above and below outlining why the latter name is now considered likely to be a synonym of *I. sphaerocephalus*.

Isopogon sphaerocephalus Lindl., *Sketch Veg. Swan R.* 34 (1840); *Atylus sphaerocephalus* (Lindl.) Kuntze, *Revis. Gen. Pl.* 2: 577 (1891). *Type*: Swan River district [Western Australia], 1839, *J. Drummond s.n.* (*lecto*: CGE [image PERTH 01553976!], *fide* D.B. Foreman, *Flora of Australia* 16: 480 (1995); *isolecto*: GH 00035491 image!, MEL 672802 image!).

Shrubs 0.3–2 m high, 0.3–1.5 m wide. *Young stems* with long patent hairs and more numerous very short coiled hairs. *Leaves* sessile, erect, simple, linear to narrowly obovate, 50–160 mm long, 4–18 mm wide, with a somewhat obtuse, mucronate apex; margins tending to be recurved throughout their length, entire; mucro erect, triangular, 1.2–1.6 mm long, dark-coloured but the tip sometimes pale or the whole mucro covered by appressed, whitish hairs. *Flower heads* solitary or crowded with one or two others at end of a stem, erect, ± globular, commonly 25–30 mm diam., with numerous, densely packed involucral and floral bracts, and subtended by very short leaves that grade into the much larger leaves below; bracts hidden when head is in full flower, very densely hairy outside with long whitish hairs. *Tepals* 10–15 mm long, cream to moderately deep yellow, usually pale yellow, separating down to the base of the pollen

presenter, which extends slightly below the base of the limb; claw glabrous throughout or with few hairs at the summit; limb 3.5–4 mm long, densely hairy with widely spreading, white hairs 0.7–2 mm long, the four parts of the limb becoming strongly curved after separating from one another. *Anthers* 2.2–2.8 mm long including terminal appendage; connective appendage 0.4–0.6 mm long, becoming dark. *Pollen presenter* 2.3–5 mm long, with an obvious constriction between the pedestal and swelling; pedestal 0.4–2 mm long, densely covered by hair-like or elongated papillae up to 0.25 mm long, which may protrude along four main longitudinal ridges to form four thick rows; swelling 0.35–0.55 mm wide; receptor 1.4–2.2 mm long, usually without papillae. *Cones* ovoid to cylindrical at first but often becoming broader when diaspores are shed; involucral bracts narrowly ovate, 7–8 mm long, attenuate or with a long apical point, with similar indumentum to the cone scales. *Cone scales* ovate or broadly ovate, as long as, or somewhat shorter than, involucral bracts; outer surface very densely hairy, with spreading hairs up to 2.2 mm long; inner surface glabrous; apical point hairy or becoming glabrous and dark. *Diaspores* ovoid, 3.5–5.3 mm long, 1.8–2.4 mm diam.; largest hairs widely spreading (with some directed downwards), 5–7 mm long; seed *c.* 3 mm long, *c.* 2 mm wide.

Diagnostic features. Distinguished from all other members of the genus by the following combination of characters: leaves linear to narrowly obovate, entire, with an erect mucro but with margins tending be recurved throughout their length; tepals usually pale yellow, with a glabrous claw and hairy limb.

Notes. An unusual characteristic of *I. sphaerocephalus* is its tendency to have slightly to markedly recurved leaf margins from the base to the apex. The closest approach to the fully recurved leaf margins of *I. sphaerocephalus* is in *I. cuneatus*, which has the base more or less flat or slightly incurved to slightly recurved. Other species of *Isopogon* have the leaf margins flat or incurved to meeting on the upper surface, or have the lamina recurved only distally.

Two geographically separated subspecies are recognised here.

a. Isopogon sphaerocephalus Lindl. subsp. **sphaerocephalus**

?*Isopogon drummondii* Hügel ex Jacques, *Ann. Fl. Pomone* ser. 2, 1: 216 (1843) [as *Drumundii*]. *Type citation*: 'Lieu originaire, la Nouvelle-Hollande'.

Isopogon eriocladus Gand., *Bull. Soc. Bot. France* 66: 228 (1919). *Type*: near Serpentine, Darling Range, Western Australia, September 1900, *W.V. Fitzgerald s.n.* (*syn*: LY *n.v.*, *fide* D.J. McGillivray, *Contr. New South Wales Natl. Herb.* 4: 344 (1937)).

Isopogon ovoideus Gand., *Bull. Soc. Bot. France* 66: 228 (1919). *Type*: Smith's Mill, Darling Range, Western Australia, September 1900, *A. Morrison s.n.* (*holo*: LY (two pieces mounted on same sheet) *n.v.*, *fide* D.J. McGillivray, *Contr. New South Wales Natl. Herb.* 4: 344 (1937)).

Illustrations. A.S. George, *Intr. Proteaceae W. Australia* 83, Plate 123 (1984); N.G. Marchant, J.R. Wheeler, B.L. Rye, E.M. Bennett, N.S. Lander & T.D. Macfarlane, *Fl. Perth Region* 1: 347, Figure 125 (1987); W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildflowers* 1: 144 (1988); D.B. Foreman, *Fl. Australia* 16: frontispiece & 220, Figure 103I (1995); J.R. Wheeler, N.G. Marchant & M. Lewington, *Fl. South West* 2: 838 (2002) [all as *I. sphaerocephalus*].

Shrubs 0.3–2 m high, lignotuberous. *Flowering branches* moderately to densely leafy, moderately to densely hairy. *Leaves* 50–160 mm long, 4–12 mm wide, glabrous or sparsely hairy. *Tepals* 10–15 mm long. *Pollen presenter* 2.3–3.3 mm long, with papillae 0.15–0.25 mm long on approximately the basal

third of the presenter; pedestal 0.4–1 mm long; swelling usually glabrous, sometimes with some very short papillae on the base, rarely with long papillae on one side only. *Diaspores* 3.5–4 mm long, *c.* 2.2 mm wide; largest hairs 5–6 mm long; seed *c.* 2.8 × 1.8 mm.

Selected specimens examined. WESTERN AUSTRALIA: McCorkill Forest Block, 22 km WNW of Nannup, 11 Nov. 2009, *R.J. Cranfield* 2441 (PERTH); reserve near corner of Hardey Rd and Strettle Rd, Glen Forrest, 15 Sep. 2008, *K.R. Thiele* 3688 (PERTH).

Distribution and habitat. This subspecies extends from near Gidgegannup (north-east of Perth) south to the Scott River area and south-east to near Kent River (Figure 1B), in lateritic areas with Jarrah forest, sometimes associated with watercourses. This distribution extends through near-coastal parts of the far south-west of Western Australia, in the Jarrah Forest, Swan Coastal Plain and Warren bioregions.

Phenology. Flowers and fruits recorded more or less throughout the year but with the main flowering season apparently from July to December.

Common name. Drumstick Isopogon.

Conservation status. Not considered to be at risk.

Synonyms. McGillivray (1973: 344) identified *I. eriocladus* Gand. and *I. ovoideus* Gand. as synonyms of *I. sphaerocephalus* after examining type material, which in both cases he considered to be holotypes. In the case of *I. eriocladus*, it appears likely that Gandoger saw only material of one kind, and only on a single sheet now housed at LY, which can therefore be assumed to be the holotype. However, for *I. ovoideus* McGillivray stated 'The type sheet bears two specimens, one in flower (on the right), the other in fruit.' In this case the type material possibly should be regarded as two syntypes rather than a holotype.

The protologue of *I. drummondii* Hügel ex Jacques (Jacques 1843) describes the leaves as sparsely distributed, undivided, linear, sessile, 60–150 mm long [as 6–15 cm] and somewhat obtuse with a rather long, white point at the apex. This description of the leaves matches that given above for *I. sphaerocephalus* although the colour of the leaf point is usually dark. However, the tip is sometimes pale and sometimes covered by appressed whitish hairs.

It is evident from the original text that the description of *I. drummondii* Hügel ex Jacques was based on glasshouse-grown specimens. In addition to giving the native country for each as 'la Nouvelle-Hollande', Jacques (1843: 217) stated that this was one of six species he had described that were cultivated by Monsieur Martine's establishment. Apparently the plants of *I. drummondii* were derived from a plant catalogue from Hügel's garden and nursery business at Hietzing near Vienna, Austria ('EUGEL cat. a.', interpreted here as Hügel's annual catalogue) under the manuscript name *I.* '*Drumundii*' (Jacques 1843: 216). In view of the epithet, it may be assumed that the original source of seed was collected by James Drummond from south-western Australia.

As is typical for Jacques's names for Australian plants, there is no known herbarium specimen that can be connected with his *I. drummondii*. We are aware of only one case of a specimen associated, albeit indirectly, with a Jacques name, that of the doubtful name *Acacia semperflorens* Jacques (see Maslin 2001; O'Leary 2007); that specimen is housed at the Florence Herbarium (FI) and came from the same garden (Jacques 1837) that was cited in the description of *I. drummondii* Hügel ex Jacques. In response to our enquiries, we were informed that there are no relevant specimens of *Isopogon* at FI (C. Nepi, pers. comm.). Despite the lack of any original material, we are confident that the protologue

is sufficient to show that it is not the same species as *I. drummondii* Benth..

Notes. The diaspore and seed measurements given above are based on diaspores from only a few specimens. From the available samples it seems likely that subsp. *lesueurensis* tends to have larger diaspores than subsp. *sphaerocephalus* but further fruiting material is needed to check this.

b. Isopogon sphaerocephalus subsp. **lesueurensis** Rye, *subsp. nov.*

Typus: Mount Lesueur area, Western Australia [precise locality withheld for conservation reasons], June 1931, *C.A. Gardner s.n.* (*holo*: PERTH 03439380).

Shrubs 0.5–1.5 m high, probably lignotuberous. *Flowering branches* densely leafy, densely or very densely hairy. *Leaves* 60–100 mm long, 7–18 mm wide, densely or moderately densely hairy. *Tepals* 13–15 mm long. *Pollen presenter* 3.5–5 mm long, with finger-like papillae 0.2–0.25 mm long on the basal half of presenter; pedestal 1.5–2 mm long; swelling with long papillae on both sides or rarely just on one side and with short papillae on the other side, also often with papillae extending upwards for a short distance onto the base of the receptor. *Diaspores* 4–5.3 mm long, 1.8–2.4 mm wide; largest hairs 6–7 mm long; seed *c.* 3.2 × 2.2 mm.

Diagnostic features. Distinguished from subsp. *sphaerocephalus* mainly by its longer pollen presenter (3.5–5 mm *cf.* 2.3–3.3 mm long), including a pedestal 1.5–2 mm long (*cf.* 0.4–1 mm long) and with long papillae on the lower half including the swelling above the pedestal (*cf.* long papillae extending for less than half the length of the pollen presenter, with the swelling usually glabrous or just with a few short papillae at the base). Plants of this subspecies also tend to be more hairy on their vegetative parts and to have more densely arranged, broader leaves (7–18 mm *cf.* 4–12 mm wide).

Selected specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 25 Aug. 1938, *W.E. Blackall* 3627 (PERTH); June 1931, *C.A. Gardner s.n.* (PERTH); 27 Aug. 1979, *E.A. Griffin* 1980 (PERTH), 26 Sep. 1976, *R.W. Johnson* 3285 (BRI *n.v.*, PERTH).

Distribution and habitat. Occurs in lateritic soils, recorded on the top of one hill and from the slopes and base of mesas, in the Mt Lesueur area (Figure 1B), north-east of Jurien Bay in the far south of the Geraldton Sandplains bioregion of Western Australia. No details of the vegetation are given but presumably this subspecies occurs in the shrublands with a high species diversity that characterise the lateritic uplands of the Mt Lesueur area. Subspecies *lesueurensis* occurs in a drier habitat and is separated by a disjunction of about 180 km from the northernmost locality known for subsp. *sphaerocephalus*.

Phenology. Flowers recorded from June to early November and fruits continuing to February.

Conservation status. To be listed under Conservation Codes for Western Australian Flora as Priority Two (A. Jones pers. comm). This subspecies has a very restricted range, being known only from three hills over a distance of a few kilometres.

Etymology. Named after the Mt Lesueur area where the taxon occurs. This area has a high biodiversity and includes several other endemic taxa, such as *Grevillea batrachioides* McGill. and *Hypocalymma tenuatum* Strid & Keighery.

Common name. Lesueur Isopogon.

Notes. The earliest collection of this subspecies was made by Charles Gardner in June 1931. One of Gardner's specimens (PERTH 01904957) bears the manuscript name *I. longifolius* var. '*villosa*' and another gathering was recorded in his collecting book as *I.* sp. *aff. sphaerocephalus* but he made no mention of the taxon in his unpublished flora treatment*. Foreman (1995: 218) described this variant of *I. sphaerocephalus* as 'a broad, hairy leaf form'.

One flowering specimen (PERTH 03418626) labelled as having been collected by Gardner from Mt Lesueur in January 1940 is of the typical subspecies and does not match a second specimen labelled with the same details (PERTH 01904957), which is in fruit. There appears to have been a mislabelling of the former specimen. Perhaps the confusion in the labelling of specimens contributed to Foreman's (1995: 218) note that the Mt Lesueur variant seemed to intergrade with the typical variant. Although some of the individual characters may show some overlap between the two subspecies, possibly mainly because of seasonal variation in most cases, there are no known specimens that cannot be conclusively identified to the subspecies level.

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*This was prepared during the 1930s for his proposed *Flora of Western Australia*. However, only the first part of Volume One, on grasses (Gardner 1952), was ever published.

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Circumscription of *Chamelaucium* (Myrtaceae: Chamelaucieae), with validation of six species names and two new combinations

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Abstract

Marchant, N.G. Circumscription of *Chamelaucium* (Myrtaceae: Chamelaucieae), with validation of six species names and two new combinations. *Nuytsia* 30: 317–334 (2019). An updated description of the genus *Chamelaucium* Desf. compiled from all currently recognised formal and informal taxa is presented to establish the status of *Chamelaucium* at generic level within the Myrtaceae, tribe Chamelaucieae. Descriptions are provided for *C. erythrochlorum* N.G.Marchant, *C. floriferum* N.G.Marchant, and its two subspecies, *C. lullfitzii* N.G.Marchant, *C. orarium* N.G.Marchant, *C. roycei* N.G.Marchant, and *C. xanthocladum* N.G.Marchant. New combinations are made and descriptions provided for *C. forrestii* (F.Muell.) N.G.Marchant, and *C. repens* (A.S.George) N.G.Marchant. Precise localities for all taxa have been withheld for conservation reasons.

Introduction

Chamelaucium Desf. is one of a group of 37 currently recognised genera placed in the Myrtaceae tribe Chamelaucieae DC. (Rye *et al.* in press). Phylogenetic and taxonomic studies on member genera are ongoing by various authors, especially in *Actinodium* Schauer, *Chamelaucium*, *Darwinia* Rudge, and *Verticordia* DC. Current phylogenetic studies by others recognise that of these four genera only *Chamelaucium* is best treated as a discrete genus as currently circumscribed (B.L. Rye, pers. com. 5 March 2019). The present paper provides a generic description of this genus recognising it as a distinct entity in the tribe Chamelaucieae, endemic to south-western Australia, and currently comprised of around 40 described and undescribed species. Six species are formally validated here and two new combinations are made. All taxa have conservation priority, including two being currently assigned 'vulnerable' status.

Methods

Descriptions of new taxa have been developed from PERTH herbarium specimens, and from field observations. Measurements were made using rehydrated flowers and leaves. Relevant type material has been studied at CGE, K, MEL and PERTH, and other specimens have been viewed on *Global Plants* (https://plants.jstor.org/).

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Circumscription of *Chamelaucium* Desf.

Taxonomic history

The generic name *Chamelaucium* dates from the publication of two species by Desfontaines (1819a). Sprengel (1825) adopted the variant spelling *Chamaelaucium* which was taken up by Candolle (1827, 1828) and used in later literature, even after the original spelling had been pointed out by Bibby (1944).

Desfontaines (1819a) based the genus on *C. ciliatum* Desf. and *C. plumosum* Desf.; subsequently, in the same volume, he added *C. brownii* Desf. (Desfontaines 1819b). The latter two species were later transferred to *Verticordia*. *Chamelaucium sensu* Desfontaines was characterised by membranous, caducous bracteoles, and either prominently ciliate calyx lobes (in *C. ciliatum*) or by each calyx lobe being deeply divided into ciliate segments (*C. brownii* and *C. plumosum*).

In 1828 A.P. de Candolle described *Verticordia* in which he placed *C. plumosum* (as *V. fontanesii* DC.) and *C. brownii*. He retained *C. ciliatum* in *Chamelaucium* which he distinguished from *Verticordia* by the lower degree of division of the calyx lobes, the included style, the form of the stigma, and absence of substigmatic hairs. *Chamelaucium ciliatum* Desf. can thus be regarded as the type species of *Chamelaucium*. This species is extremely morphologically variable and unlike almost all other members of the genus it has prominently ciliate calyx lobes and a glabrous style, both characters resembling those of some species of *Verticordia*.

Endlicher (1838) and Schauer (1844) each added another species of *Chamelaucium* (*C. virgatum* Endl. and *C. uncinatum* Schauer), both characterised by large flowers with entire, short, broad calyx lobes and entire petals.

Turczaninov, working on collections of James Drummond, described the genus *Decalophium* Turcz. (Turczaninov 1847), listing one species, *D. pauciflorum* Turcz. In 1852, he published a detailed description of this species as well as another five species of *Decalophium* (Turczaninov 1852). Bentham (1867) transferred *D. pauciflorum* to *Chamelaucium*, and added four more species to those already published; he was, however, unaware of Turczaninov's 1852 paper, and it was not until Domin (1923) that the names contained in that paper were brought to the attention of botanists with the publication of several new combinations, including *C. micranthum* (Turcz.) Domin, based on *Decalophium micranthum* Turcz.

Taxonomic confusion between the genera *Chamelaucium* and *Darwinia* partly dates from Turczaninov's description of *Genetyllis pauciflora* Turcz. (Turczaninov 1849). Turczaninov later transferred this species to his *Decalophium* (Turczaninov 1852); however, because he had already used the same epithet under that genus name in 1847, he provided the new name *Decalophium rugulosum* Turcz. *Genetyllis* had been established by Candolle in 1828, and was later regarded by Bentham (1865, 1867) as a section of *Darwinia* Rudge, referring only to south-western Australian species.

Further nomenclatural confusion resulted from the publication of the *Systematic Census of Australian Plants* (Mueller 1882), in which Mueller transferred ten species of *Chamelaucium* to *Darwinia*, and because the same epithets had been used for different taxa in the two genera, new species names were created. Although Mueller's inclusion of *Chamelaucium* in *Darwinia* was not recognised by Gardner (1931), nor subsequently by Blackall (1954) or Blackall and Grieve (1980), the difference between the two genera was not clear. This is exemplified by the number of misidentifications on herbarium

specimens, and the publication of two species of *Chamelaucium* as *Darwinia*, most likely on the basis of their exserted styles; the recombinations are made below.

Generic description

Chamelaucium Desf., *Mém. Mus. Hist. Nat.* 5: 34–44 (1819); A.P. de Candolle, *Prodr.* 3: 209 (1828). *Type species*: *C. ciliatum* Desf.

Decalophium Turcz., *Bull. Soc. Imp. Naturalistes Moscou* 20: 153 (1847). *Type species*: *D. pauciflorum* Turcz.

Shrubs up to 4 m high, widely spreading, much branched or often slender with a single lower stem, sometimes prostrate or nearly so. *Leaves* 2–30 mm long, opposite decussate, or alternate, sometimes aggregated at ends of branchlets, often borne in fascicles on short lateral shoots; linear-triquetrous, narrowly obovate to lanceolate, or ovate to elliptic, adaxial surface frequently grooved, abaxial surface flat or ± convex; margins entire or serrulate, or densely ciliate with simple or plumose hairs, rarely hyaline; apex truncate, acuminate or mucronate, sometimes minutely bifid; leaf scars persistent, usually very prominent; floral leaves undifferentiated, or shorter and broader, sometimes with a hyaline margin, or rarely ciliate with simple or plumose hairs. *Flowers* solitary or in lax or dense axillary or terminal racemes, or dichasia[1]. *Bracteoles* 0.5–7 mm long, brown or reddish, caducous or persistent, rarely connate at the base and retained to fruiting, cucullate or deeply concave and spathulate, usually umbonate on the outside at the highest part, the umbo of the inner bracteole often less prominent; umbo (when present) very prominent and curved, horn-like or barely developed. *Floral tube* 2–8 mm long, turbinate, campanulate or obconic to cylindric; lower part adnate to ovary, 1.5–5 mm long, 5 to 10-ribbed, rugose, or smooth, frequently 10-foveolate, upper part free from ovary, 0.5–4 mm long, smooth or with 10 or more ribs, or rugose, glands less prominent. *Calyx lobes* 5, 0.5–3.5 mm long, usually under 2 mm long, green, white, or reddish, semicircular, oblong, ovate, spathulate or triangular, entire, ciliate, ciliolate, crenate or irregularly dentate; sinuses narrow to wide, rarely absent. *Petals* 5, 2–7 mm long, white, often aging red, pink, purple or yellow-green, mostly obovate, ovate, or orbicular, concave, entire, ciliolate or irregularly dentate. *Stamens* 10, rarely up to 13, anthers opening by longitudinal slits; staminodes 10, rarely 12, less than 0.5 or up to 3 mm long, linear or spathulate, often divided at the tip into two uneven segments. *Style* 2–24 mm long, included, shortly exserted, or long exserted, usually dilated in lower part, most species with substigmatic hairs, which are most commonly in a band subtending the stigma. *Ovules* 4–10. *Fruit* a one-seeded nut, encased by the dried, lower part of the floral tube.

[1]Briggs and Johnson (1979) regard the inflorescence of *Chamelaucium* as either a monad, or corymbiform, racemiform or a spiciform conflorescence, or a superconflorescence.

Diagnostic features. Bracteoles cucullate and deeply concave and spathulate, not keeled, almost always with an umbo arising from the highest part of the outer bracteole. Flowers are never subtended by an involucre. The 5 calyx lobes and 5 petals are never deeply divided. The 10 anthers dehisce by two longitudinal slits, and often have a large connective. There are 10 staminodia. The stigma is usually subtended by a narrow band of hairs, and the ovule numbers range from 4 to 10.

Size and distribution. The genus comprises around 40 formally described and undescribed species, and is confined to the south-west of Western Australia where it occurs in various coastal and inland habitats from the lower Murchison to east of Esperance, with a few species associated with granitic monadnocks in the south-western forests. A number of species commonly occur in sandy and rocky soils in kwongan vegetation.

Etymology. Desfontaines (1819a) coined the generic name from the strong resemblance of the bracteoles, especially the outer bracteole, to a cape or hood. A late antique Greek word for a type of cap worn by court officials, or the hood of a monastic habit, is a καμελαύκιον, i.e. *kamelaukion* (Sophocles *et al.* 1900). In the type species *C. ciliatum* Desf., the bracteoles are brown and closely resemble the hood or cape of a medieval monk. An additional monastic hood-like character is the erect or curved, cone-shaped nipple, referred to here as an 'umbo', borne on the highest part of the bracteoles of *C. ciliatum* Desf., and most other species of the genus.

New taxa and new combinations

Chamelaucium erythrochlorum N.G.Marchant, *sp. nov.*

Type: Yoongarillup [precise locality withheld for conservation reasons], Western Australia, 19 November 1980, *G.J. Keighery* 3635 (*holo*: PERTH 04997158!; *iso*: PERTH 01257560!).

Chamelaucium sp. Yoongarillup (G.J. Keighery 3635), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium erythrochlorum N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 355 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub, erect, 0.5–1.5 m high, rarely more. *Leaves* opposite decussate, linear, 15–23 mm long, 0.7–0.8 mm wide, 0.8–1 mm deep; adaxial surface deeply grooved; margins entire, rarely serrulate; apex acuminate-mucronate; petioles 0.3–1 mm long, appressed to stem; decurrences prominent, 1.5–3 mm long. *Flowers* solitary in leaf axils forming open racemes of 1–15 flowers on young branches, 3.5–5 mm diam.; disc 2.5–4 mm diam.; pedicels 1.5–5.5 mm long, glandular, with two tiny auricles at the top, representing decurrences of the bracteoles. *Bracteoles* 2–2.5 mm long; umbo prominent, slender, erect to incurved to almost horizontal, to 1.5 mm long. *Floral tube* green, obconic-turbinate 5.5–8 mm long; lower part of floral tube 2.5–4 mm long, strongly 10-ribbed, rugose, glandular, foveolae not obvious; upper tube 3–4 mm long, sometimes clearly 10-ribbed, frequently ribs indistinct. *Calyx lobes* red-pink, triangular-ovate to oblong with a triangular-rounded apex, 1.5–2.5 mm long; margins ciliate to shallowly lacerate; sinuses narrow. *Petals* bright red, erect, obovate-broadly obovate, concave, ± hooded, with a narrowed base adnate to the staminal tube, 4.5–6.5 mm long; margins ciliate to shallowly lacerate. *Stamens* in a tube 0.2–1 mm long, the sepaline stamens set slightly lower than the petaline; filaments narrowly oblong, slightly broader at the base, 0.5–1 mm long; anthers 0.5–0.6 mm diam., connective darker, red-brown, swollen; staminodes narrowly oblong, sometimes slightly wider towards the base, 0.8–1.8 mm long, adaxial surface frequently slightly concave so that the expanded apex is shortly hooded; apex shortly lobed, one lobe frequently longer (to 0.3 mm) and darker coloured. *Style* well exserted, 16–24 mm long; stigma barely broader than the upper part of the style, convex, 1 mm diam., subtended by a band of hairs; substigmatic hairs filiform, 0.5–0.6 mm long. *Ovules* 6–10.

Diagnostic features. Tall spindly shrub with a single stem at the base. The floral tube is bright green and the corolla red and the style is well exserted.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 7 Jan. 1997, *N. Casson & B. Evans* SC137.9 (PERTH); 13 Dec. 2001, *R.J. Cranfield* 17674 (PERTH); 12 Nov. 1957, *H.E. Dawson s.n.* (PERTH); 26 Nov. 1975, *A.S. George* 14219 (PERTH); 6 Feb. 2002,

J. Liddelow s.n. (PERTH); 20 Dec. 1978, *N.G. Marchant s.n.* (PERTH); 7 Feb. 1989, *G. S. McCutcheon* 1994 (PERTH); 10 Dec. 1985, *S. Patrick* 219 (PERTH); 28 Dec. 1976, *B.L. Rye* 76040 (PERTH); 21 Jan. 1993, *G. Wardell-Johnson* 3177 (PERTH).

Phenology. Flowers from November to February.

Distribution and habitat. Restricted to remnant localities on the foothills and more widespread in the Whicher Range scarp and nearby jarrah forest and jarrah marri woodlands. Grows on lateritic soil, pale sandy clay, or loam soils.

Conservation status. Currently listed as Priority Four under Conservation Codes for Western Australian Flora. Listed (Smith & Jones 2018) under the name *C.* sp. Yoongarillup (G.J. Keighery 3635).

Etymology. From Greek words *erythros* for red, and *chloros* for green, referring to the bright red corolla and bright green floral tube.

Chamelaucium floriferum N.G.Marchant, *sp. nov*.

Type: Walpole Nornalup National Park [precise locality withheld for conservation reasons], Western Australia, 10 November 1976, *N.G. Marchant s.n.* (*holo*: PERTH 06763324).

Chamelaucium floriferum N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 355 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub, erect, 0.6–3 m high. *Leaves* distinctly opposite decussate, vertically oriented or spreading, linear, ± triquetrous, 7–20 mm long, 0.5–0.9 mm wide, 0.6–1 mm deep; adaxial surface usually deeply grooved; apex usually acute, sometimes finely bifid, rarely obtuse; petioles 0.4–1 mm long, usually appressed to stems; decurrences usually paler coloured than stems, 0.6–6(–12) mm long *Flowers* solitary in upper axils forming racemes of 2–12(–16) flowers, 5.5–8 mm diam. at maturity; disc 2–2.4 mm diam.; pedicels 2–10 mm long, erect or spreading. *Bracteoles* 2–3.3 mm long, rarely longer; umbo usually prominent, incurved, narrowly to broadly conic, and laterally compressed, 0.5–0.9(–1.6) mm long, or only 0.1–0.3 mm long, or obscure. *Floral tube* narrowly campanulate to broadly campanulate, glandular, shallowly 10-ribbed or ribbing sometimes obscure, shallowly rugose, shallowly pitted or ± smooth, 2.5–4.5 mm long; lower part of tube 1.3–3.4 mm long, with or without 10 shallow foveolae on the upper part; upper part of tube 0.8–1.4 mm long. *Calyx lobes* broadly triangular-deltate to shallowly triangular, 0.5–0.8 mm long; margins usually entire, sometimes irregularly serrulate-serrate near the apex; sinuses wide. *Petals* white, pink, or reddish ± erect-spreading; concave, broadly obovate-orbicular, 2.6–3.5(–4.5) mm long; margins entire or finely uneven to shallowly crenate, sometimes with a few scattered serrations. *Stamens* in a tube 0.2–0.8 mm long, with filaments and staminodes borne at the same level; filaments usually narrowly triangular-triangular, or sometimes widening at the base and linear above, 0.5–1.5 mm long; anthers 0.4–0.5 mm diam.; connectives swollen; staminodes narrowly triangular or linear, sometimes slightly dilated in the subapical region, 0.5–1 mm long; apex acute, reddish. *Styles* shortly exserted, usually thickened at the base, 2.5–3.5(–4.5) mm long; stigma dilated, hemispherical-subglobose, 0.3–0.4 mm diam. and subtended by a band of hairs, but sometimes globose and papillose; substigmatic hairs (when present) reflexed, filiform, 0.3–0.4 mm long. *Ovules* 7–9.

Etymology. The name is derived from Latin *flos*, a flower, and *ferre*, bear, an adjectival form implying many flowers.

Notes. Two subspecies are recognised.

Key to subspecies

1. Compact shrub; leaves vertically oriented, light green, rigid; pedicels 2–7.5 mm long, as short as flower, or slightly longer than the flower .... **C. floriferum** subsp. **floriferum**

1: Diffuse-branched shrub; leaves mostly horizontally oriented, dark green, flaccid; pedicels 6–10 mm long, longer than the flower............ **C. floriferum** subsp. **diffusum**

Chamelaucium floriferum subsp. **floriferum**

Shrub to 0.2 m high, with a distinctly trullate outline. *Leaves* vertically oriented, 7–15 mm long, rigid, light green. *Flowers* crowded in upper axils, as long as subtending leaves, slightly shorter or sometimes exceeding leaves; pedicels 2–7.5 mm long, as short as flower or slightly longer. *Petals* white, pink or reddish.

Diagnostic features. Floriferous pine-like shrub with rigid, vertically oriented, light green leaves. Pedicels as short as the flower or slightly longer. Flowers white, pink or reddish, crowded in upper axils.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 18 Dec. 1990, *A.R. Annels* 1513 (PERTH); 6 Oct. 2007, *M. Crowhurst* 173 (PERTH); 26 Nov. 1997, *E.D. Middleton* 103 (PERTH); 9 Oct. 2005, *E.D. Middleton* 739 (PERTH); 7 Dec. 1986 *A.S. Weston* 15258 (PERTH); 22 Sep. 1992, *J.R. Wheeler* 3253 (PERTH).

Phenology. Flowers between September and December.

Distribution and habitat. Found in near-coastal areas from just west of Point Nuyts to Mt Hopkins, in open coastal heath, and thickets, on sandy or loam soils between granitic outcrops or on sandy soil over limestone above granitic country rock.

Conservation status. Recently up-graded from Priority Three to Priority Two under Conservation Codes for Western Australian Flora. Listed under the erroneous informal name *C.* sp. Walpole (P.G. Wilson 6318); see note under *C. floriferum* subsp. *diffusum* below [accessed 24 June 2019].

Notes. This subspecies is widely cultivated and is known as 'Walpole Wax'. Artificial hybrids have been created with *C. uncinatum*. It is restricted to a few hundred metres from the coast and may be subjected to salt spray. It retains its form and rigid leaf characters in cultivation. Some specimens from the eastern part of the range, a short distance inland near Mt Hopkins, resemble *C. floriferum* subsp. *diffusum.*

Chamelaucium floriferum subsp. **diffusum** N.G.Marchant, *subsp. nov.*

Type: Walpole Nornalup National Park [precise locality withheld for conservation reasons], Western Australia, 12 November 1976, *N. Marchant* 76/125 (*holo*: PERTH 06796443).

Chamelaucium sp. Nornalup (N.G. Marchant 76/125), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium sp. Walpole (P.G. Wilson 6318), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019]. This specimen is not the typical subspecies. It is *C. floriferum* subsp. *diffusum*; see Notes below.

Chamelaucium floriferum subsp. *diffusum* N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 355 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub to 3 m high, with diffuse branching. *Leaves* usually at right angles to stem, 15–20 mm long, flaccid, dark green, widely spaced. *Flowers* in open racemes; pedicels up to 10 mm long, longer than flowers. *Petals* white or pale pink. (Figure 1)

Diagnostic features. A many-flowered, open diffuse-branched shrub, not pine tree-like or trullate in outline. Leaves usually at right angles to stem and generally distantly spaced. Pedicels longer than flowers, up to 10 mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 25 Nov. 1985, *A.R. Annels* 1870 (PERTH); 7 Jan. 2003, *J.A. Cochrane* 4530 (PERTH); 23 Oct. 2007, *M. Crowhurst* 136 (PERTH); 7 Nov. 2007, *M. Crowhurst* 180 (PERTH); 28 Nov. 2000, *G. Freebury* 35 (PERTH); 7 Aug. 1980, *N.G. Marchant* 80/65 (PERTH).

Phenology. Peak flowering is between August and December; some populations may flower between January and May.

Distribution and habitat. Sandy loam apron soils of granitic rocks, away from the coast. Populations are scattered and associated with granitic monadnocks from Kent River near Denmark, westwards to south east of Northcliffe.

Conservation status. Currently listed as Priority Two under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *Chamelaucium* sp. Nornalup (N.G. Marchant 76/125), [accessed 24 June 2019].

Etymology. The subspecies name refers to the diffuse branching habit.

Notes. The specimen used to represent the temporary name *C.* sp. Walpole (P.G. Wilson 6318) is *C. floriferum* subsp. *diffusum*. It was collected at the type locality for this subspecies, an inland locality, and not the near-coastal habitat of the typical subspecies.

Chamelaucium forrestii (F.Muell.) N.G.Marchant, *comb. nov*.

Darwinia forrestii F.Muell., *Fragm.* 11: 9 (1878). *Type*: In rupibus graniticis ad summitatem montis. Burrobunup prope flumen Gordon's River [Western Australia], December 1877, *F. Mueller s.n.* (*lecto* here designated: MEL 2290893!; *isolecto*: CGE!, GH 00068981!, MEL 726509!, MEL 726510!, MEL 2290894!, PERTH 06796427!).

Chamelaucium sp. Mt Frankland (A.S. George 11117), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

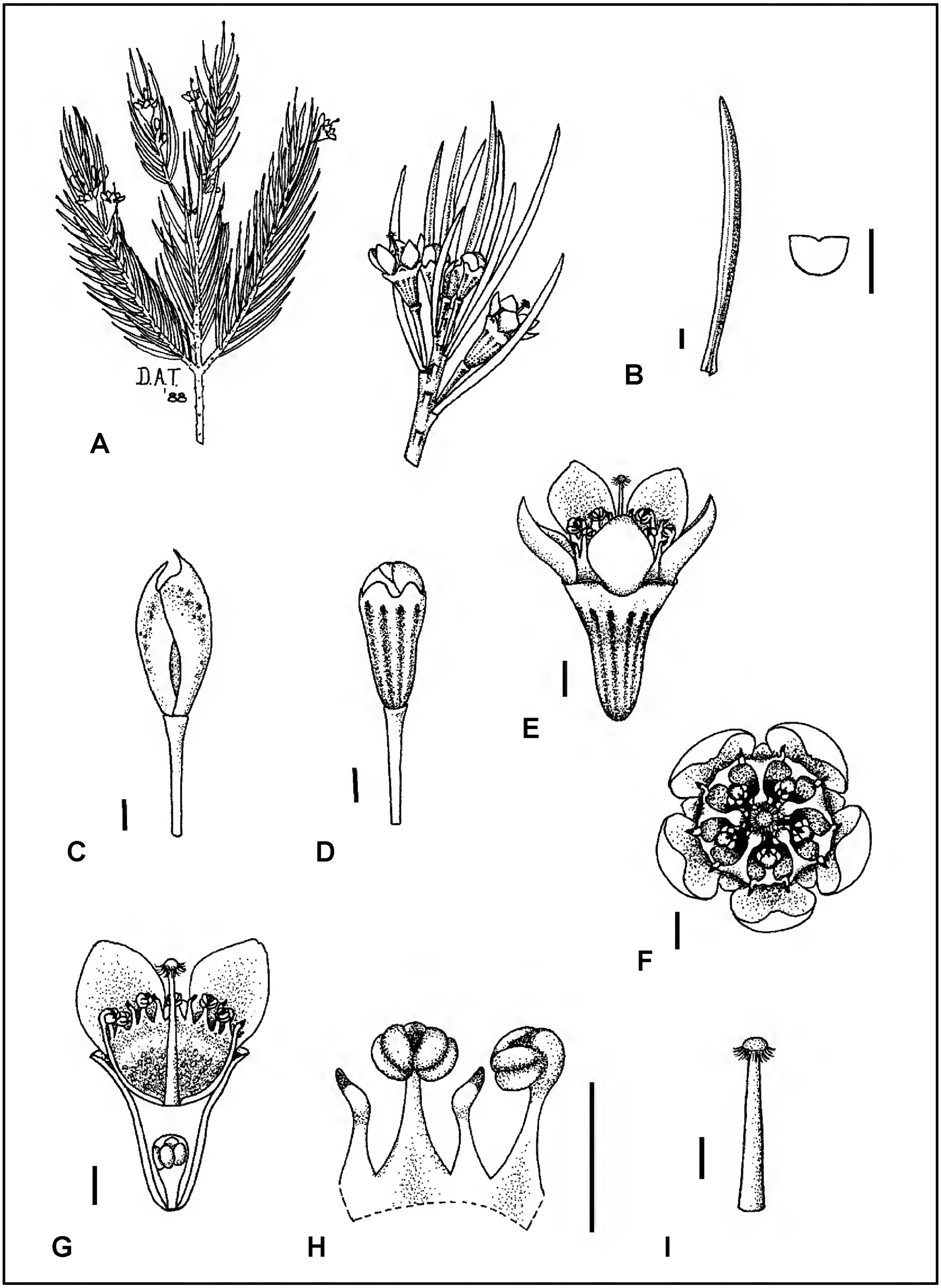

Figure 1. *Chamelaucium floriferum* subsp. *diffusum*. A – flowering leafy shoot and close-up; B – leaf, side view and cross section; C – flower bud surrounded by overlapping bracteoles, each with an umbo; D – flower bud, bracteoles removed; E – flower at anthesis; F – flower from above; G – flower in longitudinal section; H – staminodia and stamens with front and side view of anthers; I – style showing band of substigmatic hairs. Scale bars = 1 mm. Drawn by Donna Terrington from *N.G. Marchant* 80/65 (PERTH 01170864).

Chamelaucium forrestii (F.Muell.) N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 355 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub, erect, up to 2 m high, sometimes broadly spreading up to 2 m across. *Leaves* opposite decussate, erect, dark green, linear, 10–24 mm long, 1–1.5 mm diam., somewhat fleshy; adaxial surface deeply grooved; margins entire; apex truncate with two, minute, lateral mucrones; petioles to 1 mm long, appressed to stem; decurrences pale coloured, prominent. *Flowers* solitary in upper leaf axils, forming open racemes of 1–15 flowers on young branches, 3–4 mm diam.; disc 2.5–3 mm diam.; pedicels 3–6 mm long, deflexed so that flowers are well clear of the erect leaves. *Bracteoles* 4–5 mm long, 3mm across, deeply cucullate; umbo acuminate 0.8–1 mm long. *Floral tube* narrowly obconic, 3.5–5 mm long; lower part of floral tube 2.5–3.5 mm long, ribbed, rugose, foveolae 10; upper part of floral tube 1–1.5 mm long, ribs not prominent, intervening surfaces finely pitted. *Calyx lobes* broadly triangular, 1–1.5 mm long, 1.5–1.7 mm across; margins minutely serrate, apex angular. *Petals* cream coloured, tinged green, erect, obovate-broadly obovate, deeply concave, 2.5–3.5 mm long; margins entire. *Stamens* in a tube 0.5 mm long, filaments narrowly triangular, 0.5–0.6 mm long; anthers 0.3–0.5 mm diam., connective thickened; staminodes narrowly oblong, slightly broader in upper part, 0.3–0.5 mm long, longer than the stamens; apex obtuse. *Style* exserted, sometimes well exserted, 4–6.5 mm long; stigma convex, 0.4–0.6 mm across, subtended by a band of somewhat reflexed, straight hairs, 0.3–0.4 mm long. *Ovules* 4–6.

Diagnostic features. Leaves dark green. Style excluded. Flowers on deflexed pedicels clear of the erect leaves. Floral tube foveolate.

Distribution and habitat. The species grows on granitic monadnocks in high rainfall jarrah and karri forest.

Etymology. The epithet commemorates John Forrest, who as an explorer collected specimens for von Mueller.

Notes. The type locality, Burrobunup, is an early name for Granite Peak.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Oct. 1971, *A.S. George* 11117 (PERTH); 21 July 2009, *J. Liddelow* 81 (PERTH); 17 June 2010, *J. Liddelow* 132 (PERTH); 3 Oct. 1971, *N.G. Marchant* 76/114 (PERTH); 9 Nov. 1976, *N.G. Marchant* 76/114 (PERTH); 15 June 1997, *E.D. Middleton* 34 (PERTH); 30 Sep. 1997, *E.D. Middleton* 52 (PERTH); 7 Nov. 1998, *E.D. Middleton* 186 (PERTH); 13 Oct. 1976, *B.L. Rye* 76009 (PERTH); 10 Nov. 1990, *I.B. Wheeler* 43 (PERTH).

Phenology. Peak flowering is between July and November, also recorded as early as May and as late as January.

Distribution and habitat. Associated with granitic monadnocks in humic sandy and loamy soils in high rainfall jarrah and karri forests in the Mount Frankland district.

Conservation status. Recently up-graded from Priority Three to Priority Two under Conservation Codes for Western Australian Flora. Listed under *Chamelaucium* sp. Mt Frankland (A.S. George 11117), [accessed 24 June 2019].

Chamelaucium lullfitzii N.G.Marchant, *sp. nov*.

Type: between Muchea and Gingin [precise locality withheld for conservation reasons], Western Australia, 16 September 1987, *N.G. Marchant* 6 (*holo*: PERTH 07576196; *iso*: CANB, K, MEL, NSW).

Chamelaucium sp. Gingin (N.G. Marchant 6), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium lullfitzii N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 356 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub 100 to 200 cm high, with many erect branches bearing numerous, short axillary shoots 5–20(–30) mm long. *Leaves* semi-spreading to spreading, mostly crowded on the numerous short axillary shoots, narrowly obovate-very narrowly obovate or linear-narrowly elliptic, or sometimes very narrowly elliptic, 5.5–11.5 mm long, 1.2–1.4 mm wide, 0.6–0.8 mm deep; adaxial surface flat; abaxial surface convex, rounded or angular, plano-convex to triquetrous; margins entire; apex mucronate; petiole 0.5–1.5 mm long, appressed; decurrences prominent; floral leaves flattened, ovate-triangular-oblong, 1.3–2.2 mm long, 0.9–1.3 mm wide; adaxial surface concave; margins rarely ciliate on the upper half; apex mucronate; decurrences strongly and abruptly raised but short, 0.2–0.6 mm long. *Flowers* 2–9 in small heads on axillary shoots and up to 20 in the clusters at the end of main branches, 6.5–9 mm diam.; disc 3–4.2 mm diam.; pedicels 0.8–2 mm long. *Bracteoles* 3.5–4.5 mm long; umbo incurved, narrowly conic-acicular, 0.3–1 mm long. *Floral tube* broadly or very broadly obconic to broadly or very broadly turbinate, 4.4–5.4 mm long; lower part of floral tube 2.8–3.4 mm long, not foveolate, shallowly 10-ribbed; upper part of tube 1.5–2.2 mm long, obscurely ribbed or smooth. *Calyx lobes* ± erect, ovate, glandular, 2–2.8 mm long; margins irregularly denticulate and ciliate, cilia 0.5–2 mm long; sinuses wide. *Petals* white, ± erect, broadly elliptic-broadly obovate, concave, 4.6–6 mm long; margins irregularly denticulate or very sparsely and finely ciliate. *Stamens* in a tube 0.6–1 mm long, erect or arching inwards; sepaline and petaline stamens similar; filaments narrowly triangular, 0.7–1.1 mm long; anthers 0.4 mm long, connective not prominent; staminodes oblong-narrowly ovate, 0.9–1.3 mm long; apex obtuse or acute. *Styles* narrowly conic, 6.2–7.1 mm long, reaching to the top of petals; stigma strongly dilated resembling a swollen disc, finely papillate, 0.5–0.6 mm diam.; subtended by hairs from the base of the disc and directed downwards, hairs 0.4–1 mm long. *Ovules* 5–8.

Diagnostic features. Spindly erect, few-branched shrub with terminal leafy inflorescences of broad, white-petaled flowers when mature. Flowers on very short pedicels; floral tube broad; petals up to 6 mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 Nov. 1995, *J.A. Cochrane* 1703 (PERTH); 9 Dec.1995, *J.A. Cochrane* 1813 (PERTH); 21 Nov. 2008, *B. Fellows* 7 (PERTH); 20 Oct. 2010, *F. & J. Hort* 3700 (PERTH); 19 Oct. 2009, *M. Hoskins* 25 & *F. Felton* (PERTH); 22 Sep. 1992, *S. Patrick* 1246 (PERTH).

Phenology. Flowers from September to December.

Distribution and habitat. Restricted to a very small area associated with the Gingin scarp, south of Gingin. Plants grow on white, grey, or yellow sands in low open banksia woodland.

Conservation status. Listed as Vulnerable in Western Australia (Smith & Jones 2018), under the name *Chamelaucium* sp. Gingin (N.G. Marchant 6) [accessed 24 June 2019].

Etymology. Named after George Lullfitz, native plant enthusiast who pioneered the widespread use of Western Australia native plants in landscaping and who first recognised this taxon as an undescribed species.

Chamelaucium orarium N.G.Marchant, *sp. nov*.

Type: Cape Vancouver [precise locality withheld for conservation reasons], Western Australia, 18 September 1978, *I. Abbott s.n.* (*holo*: PERTH 01259679!; *iso*: CANB!, K!, MEL!, NSW!).

Chamelaucium sp. Cape Vancouver (B. Swainson & D. Davidson s.n. PERTH 1259660), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium forrestii subsp. *orarium* N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 355 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub, erect, 0.8–1.5 m high. *Leaves* opposite decussate, erect, linear, 10-27 mm long, mostly aggregated at ends of branches; adaxial surface grooved; margins entire; apex truncate with two, minute, lateral mucrones; petioles 1.5–2.5 mm long, appressed to stem; decurrences prominent, tinged yellow. *Flowers* solitary in upper leaf axils, erect, barely exceeding leaves, forming open racemes of 1–12 flowers on young branches, 3.5–5 mm diam.; disc 2.5–4 mm diam.; pedicels 1.5–4 mm long, erect. *Bracteoles* 5 mm long, 3 mm across; umbo prominent, acuminate, up to 2.2 mm long, incurved. *Floral tube* narrowly campanulate, 5–7 mm long; lower part of floral tube 3–4 mm long, 10-ribbed, ribs widely spaced, intervening surface distinctly rugose, foveoli absent; upper part of floral tube 1.5–2 mm long, ribs divided into three branches, intervening surfaces finely pitted. *Calyx lobes* triangular, 0.5–1 mm long and across; margins minutely serrate, apex rounded. *Petals* cream coloured, spreading at maturity, obovate-broadly obovate, shallowly concave, 3.5–5 mm long; margins entire. *Stamens* in a tube 0.3 mm long, filaments broader at the base, 0.5–1 mm long; anthers 0.5–0.6 mm diam., connective thickened; staminodes narrowly oblong, slightly wider at the base, 0.6–1 mm long; apex obtuse, sometimes slightly widened. *Style* included 2–4 mm long; stigma convex, 0.4–0.7 mm diam., the base subtended by a band of crinkled hairs, 0.5–0.8 mm long. *Ovules* 6–8.

Diagnostic features. Floral tube narrowly campanulate. Ribs widely-spaced, each dividing into three in upper part. Style included. Flowers shorter than leaves; pedicels erect, up to 4 mm long. Foveolae absent.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] Oct 1976, *I. Abbott s.n.* (PERTH); 28 Dec 2003, *J.A. Cochrane* 4868, *T. Friend & S. Hands* (PERTH); 10 Dec.1986, *G.J. Keighery* 8586 (PERTH); 28 Oct. 1993, *C.J. Robinson* 1189 (PERTH); 10 Oct. 1984, *B. Swainson & D. Davidson s.n.* (PERTH).

Phenology. Flowering recorded for September to December.

Distribution and habitat. Only recorded for a single locality on sea cliffs east of Albany. Grows in low coastal heath, and tall shrub thickets on white or grey sand associated with granitic outcrops.

Conservation status. Currently listed as Priority Two under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *Chamelaucium* sp. Cape Vancouver (*B. Swainson & D. Davidson s.n.* PERTH 1259660).

Etymology. The subspecies name is derived from the Latin word *ora*, meaning of the coast.

Chamelaucium repens (A.S.George) N.G.Marchant, *comb. nov.*

Darwinia repens A.S.George, *J. Roy. Soc. Western Australia* 50: 99 (1967). *Type*: 15 miles east of Mingenew [Western Australia], August 1955, *A.R. Main s.n.* (*holo*: PERTH 01018671!; *iso*: K 000566466!, MEL 2290895!, PERTH 01018663!, PERTH 01018665!).

Chamelaucium sp. Canna (G. Keighery *s.n.* PERTH 02236435), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium repens (A.S.George) N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 356 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub, prostrate or almost so, branches to 0.1 m long, bearing erect branchlets 20–40 mm long, frequently rooting at the nodes. *Leaves* in terminal fascicles, opposite decussate, vertically oriented, sometimes tinged reddish, linear-narrowly clavate, subterete-terete, (3.5–)6–11 mm long, 0.4–0.6 mm wide; apex obtuse with two very fine lateral spine-like points on the adaxial surface; petiole slightly flattened and slightly concave adaxially 0.2–0.4 mm long, with 1–3 pairs of reddish brown, flattish, ovate-triangular persistent enations 0.1–0.25 mm long in the axils; floral leaves undifferentiated; decurrences completely covering younger parts of stems, 0.3–1.4(–3) mm long. *Flowers* solitary in upper leaf axils forming a loose cluster of 1–6 on erect branchlets, 2.6–4 mm diam.; disc 1.6–2.2 mm diam.; pedicels short and stout, 0.4–1 mm long. *Bracteoles* 2.2–3 mm long, margins entire; umbo incurved, narrowly conic, 0.2–0.8 mm long. *Floral tube* cylindric, shallowly to obscurely 10-ribbed, shallowly glandular-pitted, 3–4.3 mm long; lower floral tube 1.5–2.3 mm long, without foveolae; upper tube 1.5–2.3 mm long. *Calyx lobes* erect, sparsely fine-glandular, broadly to very broadly ovate, 0.6–1.2 mm long; margins irregularly dentate and ciliate to shallowly incised; sinuses wide. *Petals* red, erect, concave, ovate-ovate elliptic, 2.6–3.6 mm long, 1.2–1.9 mm wide; margins entire to minutely undulate. *Stamens* in a tube 0.1–0.3 mm long; sepaline and petaline similar; filaments erect or sometimes bent inwards or ± geniculate, 0.3–0.6 mm long; anthers 3-lobed, with 2 larger lateral lobes and a smaller dorsal one, 0.35–0.55 mm diam.; connectives enlarged; staminodes erect or bent into floral tube, narrowly obtrullate-oblong, 0.3–0.5 mm long. *Style* filiform, long exserted, 12.5–22 mm long; stigma slightly dilated, subglobose, 0.2–0.25 mm diam., papillose, subtended by a sparse whorl of hairs; substigmatic hairs 0.3–0.4 mm long, and mostly directed downwards, sometimes ± spreading. *Ovules* 6–8.

Diagnostic features. The only recorded prostrate species of *Chamelaucium*; leaves reddish, on short lateral branches. Flowers less than 5 mm long. Pedicels less than 1 mm long. Style up to 22 mm long, well exserted.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 Aug. 2005, *J. Docherty* 366 (PERTH); 23 Aug. 1990, *G. J. Keighery s.n.* (PERTH); no date, *A.R. Main s.n.* (PERTH).

Phenology. Flowering only recorded for August.

Distribution and habitat. Only recorded from a small area growing on lateritic breakaways.

Conservation status. Currently listed as Priority One under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *C.* sp. Canna (G. Keighery *s.n.* PERTH 2236435), [accessed 24 June 2019].

Etymology. The epithet is Latin for prostrate or creeping, referring to the habit.

Chamelaucium roycei N.G.Marchant, *sp. nov.*

Type: Busselton district [precise locality withheld for conservation reasons], Western Australia, 1 October 1954, *R.D. Royce* 4872 (*holo*: PERTH 01224565!; *iso*: PERTH 01224573!).

Chamelaucium sp. S coastal plain (R.D. Royce 4872), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium roycei N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 356 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub to 120 cm high and 60 cm diam., branches tangled; brown to reddish. *Leaves* opposite decussate, widely spaced, usually spreading, narrowly oblong to linear, 4–10 mm long, 0.3–0.9 mm wide, sometimes triquetrous towards the apex, some leaves are ± flat-shallowly concave adaxially and are wider than deep; apex mucronate, sometimes acute-acuminate; floral leaves undifferentiated; petiole frequently appressed to stem, 0.2–0.5 mm long; decurrences 0.6–2(–6) mm long. *Flowers* usually in pairs in the upper leaf axils in a lax raceme with 1–12 flowers; 2.2–3 mm diam.; disc 1.4–2.4 mm diam.; pedicels (0.6–)1–2.8 mm long. *Bracteoles* 1.4–2.6 mm long; umbo prominent, ± erect, narrowly acicular, 0.6–1.3 mm long. *Floral tube* narrowly obconic to narrowly turbinate, 3.9–5 mm long, sometimes slightly falcate, green, shallowly to obscurely 10-ribbed, glandular; lower tube 2.2–3.2 mm long, without foveolae; upper tube 1.6–2.2 mm long, frequently striate. *Calyx lobes* triangular-broadly triangular-ovate, sparsely glandular, 0.6–0.8 mm long; upper margins ciliate; sinuses wide. *Petals* white, obovate, shallowly concave, 2–3 mm long; margins ciliolate-serrate; apex rounded, sometimes ± truncate. *Stamens* in a tube, 0.2–0.7 mm long, with sepaline filaments borne slightly lower than the petaline; filaments narrowly triangular, 0.3–0.6 mm long; sepaline filaments leaning inwards, or curved outwards; in some flowers slightly larger than the petaline; petaline filaments ± erect; anthers 0.3–0.7 mm diam.; connectives enlarged, frequently with a concavity on the dorsal-abaxial surface; staminodes narrowly triangular, concave adaxially, 0.5–0.9 mm long; apex shallowly hooded, acute and curved slightly inwards or ± bilobed with the adaxial lobe longer than the abaxial. *Style* usually exserted, or sometimes barely so, 6–9 mm long; apical part curved; usually thickest at slightly below the middle, then narrowing slightly to the base, or sometimes not narrowing; stigma not dilated, ± flat, papillose, subtended by a band of hairs; substigmatic hairs filiform, 0.4–0.5 mm long, usually tapering towards the tip, erect and slightly curved over the stigma. *Ovules* (4–)7–9. (Figure 2)

Diagnostic features. Low-growing tangled shrub. Leaves often reddish with a waxy appearance. Umbo acicular. Floral tube narrow, falcate. Style up to 9 mm long, curved.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 23 Oct. 2007, *E. Bennett* 15/13 (PERTH); 3 Oct. 2013, *V. Clarke s.n.* (PERTH); 2 Dec. 2009, *J.A. Cochrane* 7603 (PERTH); 3 Nov. 1993, *R.J. Cranfield* 8981 & *D. Kabay* (PERTH); 25 Aug. 1985, *G.J. Keighery* 8094 (CANB, PERTH); 9 Dec. 1976, *G.S. McCutcheon* 859 (PERTH); 3 Nov. 1947, *R.D. Royce*

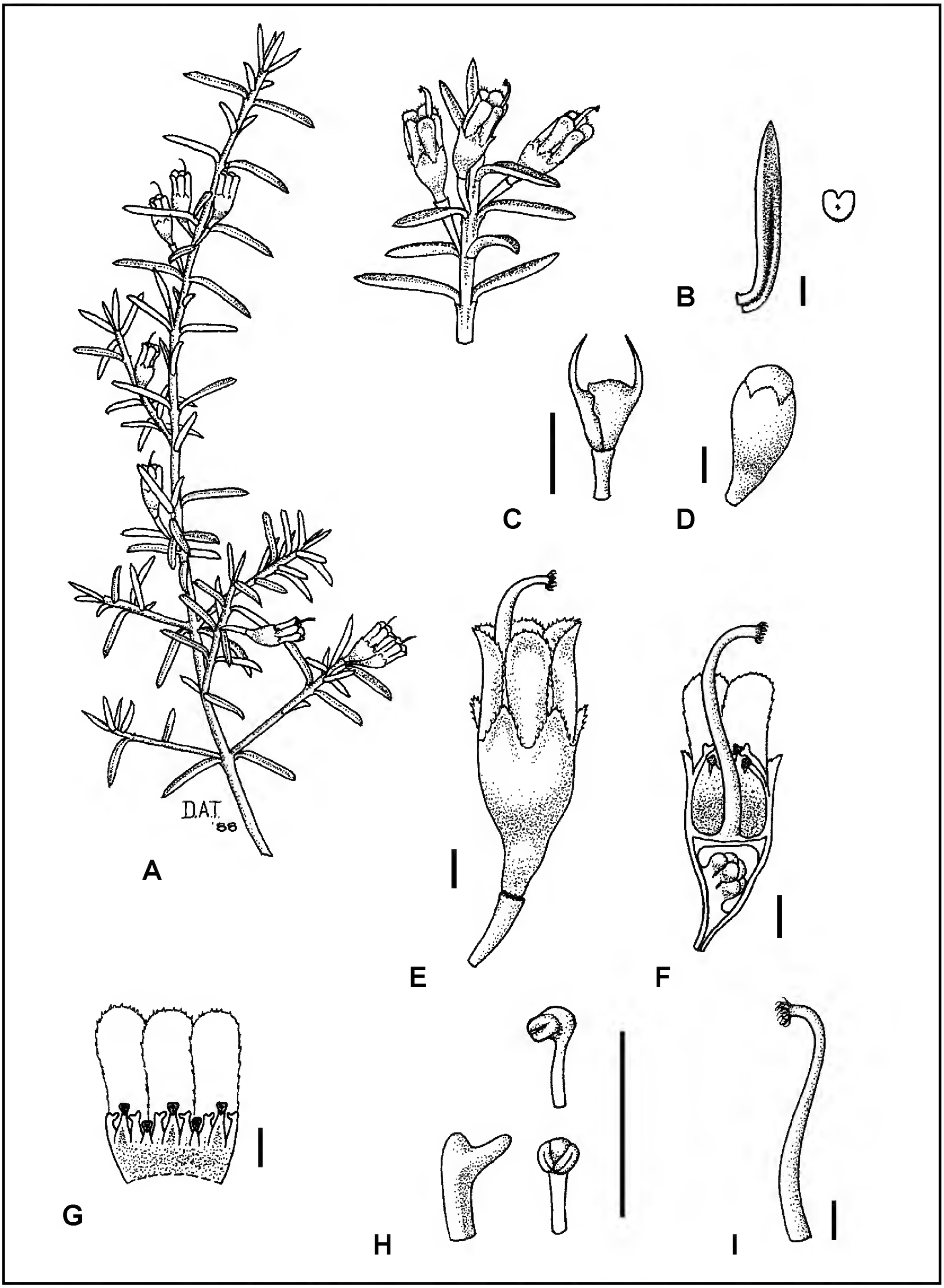

Figure 2. *Chamelaucium roycei*. A – flowering leafy shoot and close-up; B – leaf, side view and cross section; C – flower bud surrounded by overlapping bracteoles, each with a long narrow acute umbo; D – flower bud, bracteoles removed; E – flower at anthesis; F – flower in longitudinal section; G – part of upper floral tube with petals, stamens, and staminodes; H – staminode and stamens with front and side view of anthers; I – style showing band of substigmatic hairs. Scale bars = 1 mm. Drawn by Donna Terrington from *R.D. Royce* 5765 (PERTH 01227718).

2483 (PERTH); 17 Oct. 1949, *R.D. Royce* 3178 (PERTH, MEL); 8 Oct. 1957, *R.D. Royce* 5765 (AD, PERTH); 10 Sep. 1997, *A. Webb* 062 (PERTH); 23 Sep. 1997, *A. Webb* 066 & *D. Hammer* (PERTH).

Phenology. Peak flowering is from August to November with records for July and December.

Distribution and habitat. Restricted to a small area of winter wet low-lying habitats in open forest of the Donnybrook sunklands south of Busselton. Grows on red lateritic sandy or clayey soils.

Conservation status. Listed as Vulnerable in Western Australia (Smith & Jones 2018), under the name *C.* sp. S coastal plain (R.D. Royce 4872),

Etymology. Named after Robert Dunlop Royce, a cadet of the Department of Agriculture from 1934, who joined the Botany Branch and Western Australian Herbarium in 1944 to become the Curator of the herbarium from 1960 to 1974. He made numerous plant and algal collections in the state, especially of plants in the Busselton–Margaret River area during his many annual trips certifying clover seed. He was the first to collect *C. roycei* in 1947 and made a further four collections of the species over the next ten years.

Chamelaucium xanthocladum N.G.Marchant, *sp. nov.*

Type: Waychinicup [precise locality withheld for conservation reasons], Western Australia, 28 October 1990, *N.G. Marchant* 90/10/7 (*holo*: PERTH 06763308).

Chamelaucium sp. Waychinicup (D. Davidson s.n. PERTH 01486527), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Chamelaucium aerocladus N.G.Marchant & Keighery ms; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* 354 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 June 2019].

Shrub 100–150 cm high or more in moist, sheltered habitats; branches weeping, with closely packed yellowish green young stems and leaves, decurrences, 2–5 mm long, widely spaced. *Leaves* opposite, linear, appressed to stem, 10–20 mm long, 0.5–0.7 mm wide; abaxial surface rounded, adaxial surface with a shallow groove in lower part, apex minutely bifid; petiole 0.5–1 mm long. *Flowers* few, 1–2 in upper axils, 5–7 mm diam.; disc 2.3–3.5 mm diam.; pedicel 3.7–5.4 mm long. *Bracteoles* mostly comprised of a broad based, acuminate umbo. *Floral tube* turbinate to narrowly turbinate, 4–6 mm long; lower part 2.8–4.4 mm long, surface shallowly rugose, without ribs; upper part 1.4–2 mm long, smooth; foveolae absent. *Calyx lobes* 0.2–0.6 mm long, very broadly triangular to hemispheric; margins entire or with small serrations, sinuses very broad. *Petals* creamy white to greenish cream, 2.5–4.4 mm long, erect, obovate to ovate, deeply concave, margins entire or with minutely serrate margins. *Stamens* united in a tube 0.3–0.5 mm long; anthers 0.4–0.6 mm long, antisepalous stamens and staminodes geniculate and antipetalous stamens and staminodes erect or all stamens and staminodes geniculate; connective globose, reddish brown or cream; staminodes narrowly triangular, 0.4–0.6 mm long, apex obtuse. *Style* exserted, 4.7–5.5 mm long, very broad towards the base; stigma capitate, 0.7–0.9 mm diam., subtended by a band of hairs; substigmatic hairs white, 0.3–0.5 mm long. *Ovules* 4–6. (Figure 3)

Diagnostic features. The distinctly weeping branches and the thin, yellow-green leaves and the often-greenish flowers distinguish this species from all other south coast species.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 1 Oct. 2010, *S. Barrett & S. Comer* 1978 (PERTH); 7 Oct. 2008, *S. Barrett & G. Freebury* 1783 (PERTH); 11 Dec. 2000, *J.A. Cochrane* 3792 (PERTH); 17 Nov. 1986, *E.J. Croxford* 5498 (PERTH); 15 Oct. 1984, *D. Davidson s.n.* (PERTH); 27 Aug. 1986, *D. Davidson s.n.* (PERTH).

Phenology. Flowers from late August through to January.

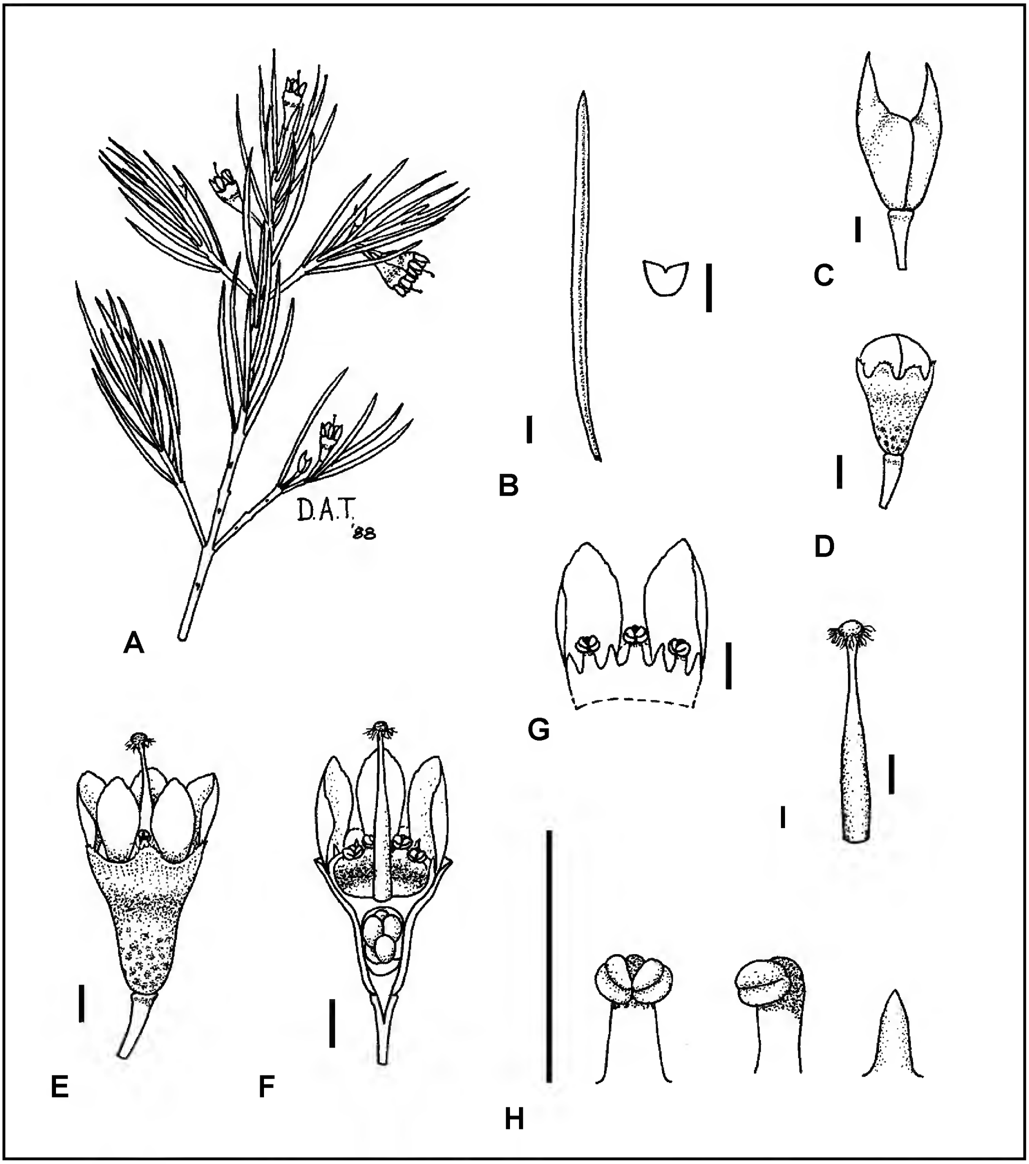

Figure 3. *Chamelaucium xanthocladum*. A – flowering leafy shoot; B – leaf, side view and cross section; C – flower bud surrounded by overlapping bracteoles, each with a broad-based umbo; D – flower bud, bracteoles removed; E – flower at anthesis; F – flower in longitudinal section; G – part of upper floral tube with petals, stamens, and staminodes; H – staminode and stamens with font and side view of anthers; I – style showing ring of substigmatic hairs. Scale bars = 1 mm. Drawn by Donna Terrington from *D. Davidson s.n.* (PERTH 01486527).

Distribution and habitat. Restricted to a limited range in heathland and coastal thickets between Albany and Cheyne Beach, Western Australia. Grows on brown sandy or loam soils associated with granitic outcrops.

Conservation status. Currently listed as Priority Two under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *C.* sp. Waychinicup (D. Davidson s.n. PERTH 01486527).

Etymology. The species name is derived from the Greek words *xanthos*, yellow, and *clados*, branches.

Acknowledgements

The taxonomic skills of Chin See Chung are acknowledged for his excellent support. Greg Keighery provided much valuable field knowledge and advice in the early stages of studies on *Chamelaucium* and *Darwinia*. Annette Wilson, Barbara Rye and other staff of the WA Herbarium, PERTH are sincerely thanked for their help and encouragement. Donna Terrington prepared the illustrations.

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SHORT COMMUNICATION

Hibbertia tuberculata (Dilleniaceae), a new, rare species from Western Australia

During a 2009 flora and vegetation survey of the Forrestania Greenstone Belt (Thompson & Allen 2013), a specimen of *Hibbertia* Andrews was collected from a rocky basalt area east of North Ironcap and north-west of Lake Cronin Nature Reserve. The specimen closely matched an earlier collection provisionally determined by J. Wheeler at the Western Australian Hebarium as *H.* aff. *oligantha* J.R.Wheeler, collected by Ken Newbey in 1981 from a nearby locality. Subsequently, further collections have been made from the Mount Holland area *c.* 20 km further north. The specimens are consistent, distinctive and not referable to any known species; accordingly, they are here described as *H. tuberculata* K.R.Thiele *sp. nov.*

Hibbertia tuberculata K.R.Thiele, *sp. nov.*

Type: *c.* 100 km S of Southern Cross, Western Australia [precise locality withheld for conservation reasons], 23 August 2019, *B. Ellery* BE 1415 (*holo*: PERTH 09155317; iso: AD, CANB, K, MEL).

Low, spreading, woody *shrubs* to 45 cm high, with papery, exfoliating bark on all but the youngest stems, which are reddish and sparsely hairy with minute, spreading to retrorse hairs *c.* 0.02 mm long. *Leaves* crowded on new growth, erect to spreading, scattered, shortly petiolate and slightly stem-clasping at the base, green, elliptic to linear, (2–)3–5 mm long, 0.8–1.2(–2) mm wide, prominently tuberculate and sparsely hairy with short, simple hairs to 0.3 mm long, each hair arising antrorsely from a tubercle; margins revolute to the broad, tuberculate midrib, obscuring the minutely papillate true abaxial surface; apex obtuse to subacute, ± straight. *Flowers* solitary, terminating short lateral shoots, ± sessile; *bracts* 3–7, narrowly triangular to narrowly ovate, 0.8–1.2 mm long, 0.2–0.3 mm broad, acute, ± glabrous except for minutely ciliolate margins, sometimes scarious in the upper half. *Sepals* 5; outer sepals broadly ovate, acute but not pungent, (4.5–)5–6 mm long, glabrous, without a prominent midrib; inner sepals similar to the outer ones but broader and less acute. *Petals* 5, yellow, obovate, 6–8 mm long, slightly emarginate. *Stamens* (9–)12–14, free, erect, arranged on one side of the carpels, varying in size but without true staminodes; filaments free to the base, 0.5–1.9 mm long; anthers linear-oblong, 0.5–2.0 mm long, dehiscing by longitudinal slits. *Carpels* 2; ovaries ± oblong, glabrous; styles lateral and strongly reflexed from ovary apex then spreading-erect, *c.* 3–4 mm long. *Ovules* 2–4 per carpel. *Fruiting carpels* and seeds not seen. (Figure 1)

Diagnostic features. May be distinguished from all other species of *Hibbertia* in Western Australia by the combination of sessile flowers with 3–7, narrowly triangular to narrowly ovate bracts, erect stamens with free filaments on one side of the two glabrous carpels, and leaves (2–)3–5 mm long and prominently tuberculate.

Other specimens examined. WESTERN AUSTRALIA [localities withheld for conservation reasons]: 11 Sep. 2017, *D. Angus* 2916 (PERTH); 7 Oct. 1981, *K.R. Newbey* 9251 (PERTH); 5 Oct. 2009, *W. Thompson & J. Allen* 950 (PERTH).

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Figure 1. Flowering branch of *Hibbertia tuberculata*. Photo: W. Thompson (*W. Thompson & J. Allen* 950).

Phenology. The known collections were flowering in September and October.

Distribution and habitat. Occurs from Lake Cronin and North Ironcap to near Mount Holland, in the Southern Cross subregion of the Coolgardie IBRA Bioregion (Figure 2).

The type locality is a gentle slope with rocky, red-brown sandy clay soils developed on greenstone. Associated vegetation is an open heathland of *Melaleuca cliffortioides*, *Allocasuarina campestris* and *Dodonaea adenophora* over low, sparse *Grevillea lissopleura* and *Trymalium myrtillus* subsp. *myrtillus*. The Newbey specimen was collected from a gentle slope on an undulating plain of well-drained, crumbly red clay supporting *Melaleuca cardiophylla* dwarf scrub. The site near North Ironcap is a rocky hill crest with exposed greenstone bedrock and shallow red-brown clay-loam soils, where *H. tuberculata* grows with *Eucalyptus protensa*, *Santalum acuminatum*, *Allocasuarina helmsii*, *Trymalium myrtillus* subsp. *myrtillus*, *Acacia kerryana*, *A. pachypoda*, *Grevillea acuaria*, *Eutaxia nanophylla* and *Hemigenia aff. diplanthera*. All known localities are on fine and medium-grained mafic amphibolite with metabasalt regolith adjacent to banded chert (Chin *et al.* 1984).

Conservation status. The three known collection localities are all within *c.* 25 km of each other, and none is in a current conservation area. Accordingly, a status of Priority One is appropriate under the Conservation Codes for Western Australian Flora (M. Smith pers. comm.).

Etymology. From the Latin *tuberculatus* (tuberculate, covered with wart-like projections), in reference to the leaves.

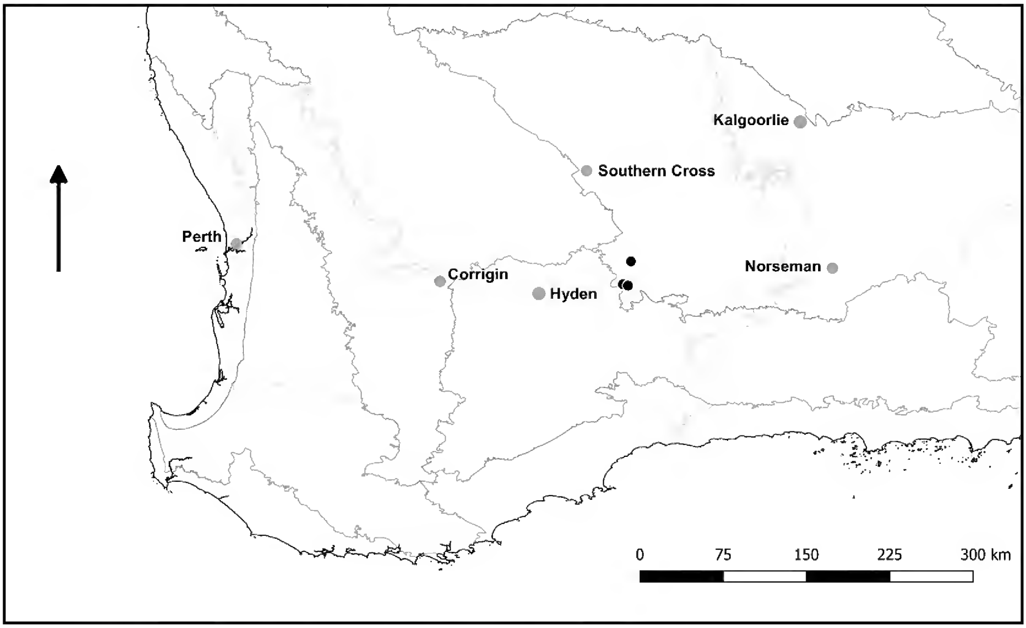

Figure 2. Distribution of *H. tuberculata*. Shaded lines show the boundaries of IBRA6.1 bioregions (Department of the Environment, Water, Heritage and the Arts, 2008).

Notes. *Hibbertia tuberculata* belongs in *H.* subg. *Hemistemma* (DC. in Thou.) J.W.Horn and is relatively unusual amongst Western Australian species of that subgenus in having erect, free stamens on one side of two glabrous carpels, and spreading-erect styles. In most other Western Australian species with stamens on one side of two carpels, the carpels are densely hairy, the staminal filaments are fused at their bases and the stamens are arranged like a hand of bananas curving forward over the carpels, with the short styles curved beneath them. Only three other Western Australian species, *H. andrewsiana* Diels, *H. psilocarpa* J.R.Wheeler and *H. oligantha* J.R.Wheeler, share this arrangement of stamens and carpels with *H. tuberculata*; the pattern is more commonly seen in eastern Australian species of subg. *Hemistemma*.

Hibbertia tuberculata is morphologically most similar to *H. oligantha*. It is a woodier shrub than *H. oligantha*, with stout branchlets and very short seasonal growth units, whereas *H. oligantha* has a softer appearance with long, more or less straight seasonal shoots. The leaves of *H. oligantha* are longer (3.5–15 mm long), narrower (0.6–1 mm wide), and are typically smooth and glabrous (occasionally with obscure tubercles), unlike the short ((2–)3–5 mm long), broad (0.8–1.2(–2) mm wide), prominently tuberculate leaves of *H. tuberculata*. The distributions of the two species do not overlap, *H. oligantha* occurring from Esperance to Ravensthorpe and inland to the vicinity of Peak Charles. Two PERTH specimens currently included in *H. oligantha* from near Salmon Gums (*R.D. Hoogland* 12051 and *W.E. Blackall* 1038) have fine, trichome-tipped tubercles. These are likely to comprise another new species, which differs from *H. tuberculata* in the finer, denser tubercles and distinctly hairy leaves.

Hibbertia psilocarpa has smooth, often glaucous leaves which, when hairy, have fine, straight, erect, non-tubercle-based hairs, 4–8(–10) stamens, and styles that are not strongly reflexed from the carpel apex. *Hibbertia andrewsiana* has slender-pedicellate flowers with a single floral bract at the apex of the often sigmoid pedicel.

Summary of taxon circumscriptions

Hibbertia tuberculata K.R.Thiele *sp. nov.* in this paper does not cause the recircumscription of any other taxon.

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SHORT COMMUNICATION

Updates to Western Australia's vascular plant census for 2019

The census database at the Western Australian Herbarium (PERTH), which provides the nomenclature for the website *FloraBase* (Western Australian Herbarium 1998–), lists current names and recent synonymy for Western Australia's native and naturalised vascular plants, as well as algae, bryophytes, lichens, slime moulds and some fungi. The names represented in the census are either sourced from published research or denote as yet unpublished names based on herbarium voucher specimens. We herein summarise the changes made to vascular plant names in this database during 2019.

Ninety-five taxa were newly recorded for the State, of which 11 are naturalised and 33 have been added to the *Threatened and Priority Flora list for Western Australia* (Smith & Jones 2018; Western Australian Herbarium 1998–) (Table 1). A total of 119 name changes were made, including the formal publication of 50 phrase-named taxa (Table 2). Plant groups for which a number of name changes were made include *Eremophila* R.Br. (Brown & Davis 2019; Chinnock 2019), *Hibbertia* Andrews (Thiele 2019a), *Hydrocotyle* L. (Perkins 2018, 2019) and *Styphelia* Sm. (Hislop 2019; Hislop & Puente-Lelièvre 2019). Numerous changes were made in *Scholtzia* Schauer in the latest of a series of papers aimed at reducing the large backlog of informally-named taxa in the Myrtaceae tribe Chamelaucieae (Rye 2019). A comprehensively illustrated revision of the tiurndins (*Tribonanthes*, Haemodoraceae) recognised 12 species, of which four were newly described and two were reinstated (Hickman & Hopper 2019). Table 2 also includes cases where there has been a change of taxonomic concept, misapplication, exclusion or rank change.

Table 1. New records added to Western Australia's vascular plant census during 2019. *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; T, P1–P4 = Conservation Codes for Western Australian Flora (Smith & Jones 2018; Western Australian Herbarium 1998–).

New Name	Status	Comments
Acacia sp. Forrestania (D. Angus DA 3001)	P1	M. Hislop *in litt.* (20/09/2019).
Actinotus sp. Whicher (G.J. Keighery 12394)		Correction to voucher-specimen identifier. See Keighery (1999).
Austrostipa echinata (Vickery, S.W.L.Jacobs & J.Everett) S.W.L.Jacobs & J.Everett	P1	New record for WA. T.D. Macfarlane *in litt.* (13/12/2018).
Boronia clavata Paul G.Wilson subsp. *clavata*	T	See Duretto (2019).
Boronia clavata subsp. *grandis* Duretto	P2	See Duretto (2019).
Boronia denticulata Sm. subsp. *denticulata*		See Duretto (2019).
Boronia denticulata subsp. *whoogarupensis* Duretto	P2	See Duretto (2019).
Boronia sp. Leeuwin (J. Scott 235)	P2	A. Webb *in litt.* (07/05/2019).

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New Name	Status	Comments
Calandrinia sp. Cape Range (F. Obbens FO 10/18)	P2	F. Obbens *in litt.* (16/11/2018).
Calandrinia sp. Nanutarra (F. Obbens FO 08/18)	P1	F. Obbens *in litt.* (16/11/2018).
Calochilus sp. Theda (R.L. Barrett et al. RLB 6158)		R.L. Barrett & T.D. Macfarlane *in litt.* (01/07/2019).
Calyptocarpus vialis Less.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/12/2018).
Cassinia sifton Orchard	*	See Orchard (2017).
Comesperma sp. A Kimberley Flora (D.W. Rust 48)		Correction to voucher-specimen identifier.
Convolvulus sp. Cascades (W. Archer 1110161)	P1	M. Hislop *in litt.* (11/07/2019).
Corchorus drysdalensis R.L.Barrett		See Barrett (2019b).
Corybas sp. Peat (A.P. Brown & D. Edmonds APB 4314)		A.P. Brown *in litt.* (21/05/2019).
Darwinia sp. Corrigin (T. Erickson TEE 308)	P2	B.L. Rye *in litt.* (03/09/2019).
Dillwynia sp. Mallee (W.R. Archer 1709959)		M. Hislop *in litt.* (10/10/2019).
Diuris sp. Augusta (G. Brockman GBB 1469)		C. French & G. Brockman *in litt.* (05/12/2018).
Drosera sp. Branched styles (S.C. Coffey 193)		S.C. Coffey *in litt.* (30/11/2018).
Elionurus tylophorus M.D.Barrett & Handasyde	P2	See Barrett & Handasyde (2019).
Eremophila sp. Kalgoorlie (V. Clarke & A. Brown VTC 590)		Correction to voucher-specimen identifier. A.P. Brown *in litt.* (30/01/2019).
Eremophila sp. Mullewa (R. Wait 7311)		R. Davis *in litt.* (09/01/2019).
Eriachne sp. Dugald River (B.K. Simon+ 3007)		M.D. Barrett *in litt.* (18/01/2019).
Eucalyptus cladocalyx F.Muell. subsp. *cladocalyx*	*	New naturalised record for WA. G.J. Keighery *in litt.* (08/07/2019).
Eucalyptus vokesensis D.Nicolle & L.A.S.Johnson		New record for WA. M.E. French *in litt.* (12/06/2019).
Exocarpos sp. Ardath (J. Buegge D 62)		B.J. Lepschi *in litt.* (30/10/2018).
Gloriosa superba L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/02/2019).
Goodenia sp. Cunyu (C.J. Nicholson & P.J. Curry 1001)	P1	K.A. Shepherd & M. Hislop *in litt.* (14/02/2019).
Grevillea sp. Yerilgee Hills (T. Laslett TL 025)	P1	J. Bull & D. Brearley *in litt.* (05/06/2019).
Habenaria hymenophylla Schltr.		New record for WA. R.L. Barrett *in litt.* (02/01/2019).

New Name	Status	Comments
Haemodorum coccineum R.Br.		New record for WA. See Barrett *et al.* (2015).
Haemodorum subvirens F.Muell.		New record for WA. See Barrett *et al.* (2015).
Heteranthera reniformis Ruiz & Pav.	*	New naturalised record for WA. M. Hislop *in litt.* (25/07/2019).
Hibbertia acrotoma K.R.Thiele	P1	See Thiele (2019a).
Hibbertia ambita K.R.Thiele	P1	See Thiele (2019a).
Hibbertia davisii K.R.Thiele		See Thiele (2019a).
Hibbertia elegans K.R.Thiele	P1	See Thiele (2019a).
Hibbertia hortiorum K.R.Thiele	P1	See Thiele (2019a).
Hibbertia improna K.R.Thiele		See Thiele (2019a).
Hibbertia inopinata K.R.Thiele		See Thiele (2019a).
Hibbertia sandifordiae K.R.Thiele	P1	See Thiele (2019a).
Hibbertia semipilosa K.R.Thiele		See Thiele (2019a).
Hibbertia spectabilis K.R.Thiele		See Thiele (2019a).
Hibbertia wheelerae K.R.Thiele	P2	See Thiele (2019a).
Hibiscus sp. Perrinvale Station (J. Warden & E. Ager WB 10581)	P3	G. Cockerton *in litt.* (05/08/2019).
Lagenophora gracilis Steetz		New record for WA. See Wang & Bean (2019).
Lagenophora platysperma Jian Wang ter & A.R.Bean		See Wang & Bean (2019).
Lagenophora stipitata (Labill.) Druce		New record for WA. See Wang & Bean (2019).
Lechenaultia sp. Cascade (W.R. Archer 212122)	P1	K.A. Shepherd & M. Hislop *in litt.* (14/02/2019).
Lepidium sp. Stirling Range (S. Barrett 1359)		G.J. Keighery *in litt.* (23/10/2019).
Leucopogon sp. Cascades (M. Hislop 3693)	P1	M. Hislop *in litt.* (07/02/2019).
Levenhookia sp. Whicher Range (J.A. Wege 2090)		J.A. Wege *in litt.* (11/04/2019).
Micrococca mercurialis (L.) Benth.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/02/2019).
Microcorys sp. Mt Holland broad-leaf (G. Barrett s.n. PERTH 04104927)	P1	M. Hislop *in litt.* (12/09/2019).
Nandina domestica Thunb.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).

New Name	**Status**	**Comments**
Nicotiana gascoynica M.W.Chase & Christenh.		See Chase & Christenhusz (2018b).
Nicotiana karijini M.W.Chase & Christenh.		See Chase & Christenhusz (2018a).
Nicotiana stenocarpa H.-M.Wheeler		New record for WA. See Chase & Christenhusz (2018c).
Opuntia polyacantha Haw.	*	New naturalised record for WA. R.J. Chinnock *in litt.* (23/05/2019).
Opuntia polyacantha var. *hystricina* (Engelm. & J.M.Bigelow) B.D.Parfitt	*	New naturalised record for WA. R.J. Chinnock *in litt.* (23/05/2019).
Phebalium sp. Yerilgee Sandplain (J. Jackson 223)	P2	J. Bull *in litt.* (24/07/2019).
Phytolacca americana L.	*	New naturalised record for WA. G.J. Keighery *in litt.* (09/07/2019).
Pterostylis sp. Bloated bird orchid (A.R. Annels et al. ARA 5478)		C. French & G. Brockman *in litt.* (05/12/2018).
Pterostylis sp. Bloated snail orchid (W. Jackson BJ 486)		C. French & G. Brockman *in litt.* (05/12/2018).
Pterostylis sp. Coastal clubbed sepals (G. Brockman GBB 255)		C. French & G. Brockman *in litt.* (05/12/2018).
Pterostylis sp. Paynes Find (G. Brockman GBB 526)		C. French & G. Brockman *in litt.* (05/12/2018).
Pterostylis sp. Robust snail orchid (W. Jackson BJ 358)		C. French & G. Brockman *in litt.* (05/12/2018).
Ptilotus xerophilus T.Hammer & R.W.Davis		See Hammer *et al.* (2019).
Rorippa sp. Fortescue Valley (M.N. Lyons & R.A. Coppen FV 0760)	P1	M.T. Collins & M.N. Lyons *in litt.* (25/06/2019).
Scholtzia brevistylis Rye		See Rye (2019).
Scholtzia halophila Rye		See Rye (2019).
Scholtzia longipedata Rye		See Rye (2019).
Scholtzia pentamera Rye		See Rye (2019).
Scholtzia pentamera subsp. *collina* Rye		See Rye (2019).
Scholtzia uniovulata Rye		See Rye (2019).
Sida sp. R (P. Copley 1390)	P1	New record for WA. R.M. Barker *in sched.* (May 2007).
Stylidium sp. Dragon Rocks (J.A. Wege & K.A. Shepherd JAW 2054)	P2	J.A. Wege *in litt.* (11/04/2019).
Styphelia sp. Wandoo (F. & J. Hort 2441)	P2	M. Hislop *in litt.* (22/01/2019).
Syncarpia glomulifera (Sm.) Nied.	*	New naturalised record for WA. G.J. Keighery *in litt.* (10/10/2018).

New Name	Status	Comments
Thysanotus sp. Ennuin (N. Gibson & M. Lyons 2665)	P1	T. Macfarlane *in litt.* (20/02/2019).
Thysanotus sp. Mount Madden (G.F. Craig 10516)	P1	T. Macfarlane *in litt.* (27/05/2019).
Thysanotus sp. Yellowdine (A.S. George 6040)	P2	T. Macfarlane *in litt.* (11/03/2019).
Tribonanthes australis Endl. × *Tribonanthes brachypetala* Lindl.		See Hickman & Hopper (2019).
Tribonanthes australis Endl. × *Tribonanthes longipetala* Lindl.		See Hickman & Hopper (2019).
Tribonanthes brachypetala Lindl. × *Tribonanthes variabilis* Lindl.		See Hickman & Hopper (2019).
Tribonanthes elongata E.J.Hickman & Hopper		See Hickman & Hopper (2019).
Tribonanthes monantha E.J.Hickman & Hopper		See Hickman & Hopper (2019).
Tribonanthes porphyrea E.J.Hickman & Hopper		See Hickman & Hopper (2019).
Triodia sp. Silvergrass (P.-L. de Kock BES 00808)	P1	M.D. Barrett & P.-L. de Kock *in litt.* (06/02/2018).
Triodia veniciae M.D.Barrett		See Barrett (2019a).
Trithuria fitzgeraldii D.D.Sokoloff, I.Marques, T.Macfarlane, Rudall & S.W.Graham		See Sokoloff *et al.* (2019).
Utricularia oppositiflora R.Br.		New record for WA. R.W. Jobson *in sched.* (06/09/2019).
Vallisneria sp. Weelarrana (M.N. Lyons & S.D. Lyons 3050)	P1	T. Macfarlane & M. Lyons *in litt.* (19/06/2019).

Table 2. Changes to existing entries in Western Australia's vascular plant census during 2019. Excluded taxon = a name used in the botanical literature that refers to a taxon never occurring in WA; misapplied name = a name used in the botanical literature but now considered to refer to one or more different WA taxa; nomenclatural synonym = a superseded name based on the same type specimen as the accepted name—the epithet is usually transferred to a different genus name or rank; taxonomic synonym = a superseded name based on a different type specimen to the accepted name; orthographic variant = mis-spelling of a name in original publication; *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; T, P1–P4 = Conservation Codes for Western Australian Flora (Smith & Jones 2018; Western Australian Herbarium 1998–).

Old Name	New Name	Status	Comments
Abutilon halophilum Schldl.	n/a		Excluded taxon. No records from WA.
Acacia sp. East Fortescue (J. Bull & D. Roberts ONS A 27.01)	*Acacia corusca* J.P.Bull, S.J.Dillon & Brearley	P1	Taxon formally published. See Bull *et al.* (2019).
Actinotus sp. Whicher (G.J. Keighery 12394)	*Actinotus whicheranus* Keighery	P2	Taxon formally published. See Keighery (1999).

Old Name	New Name	Status	Comments
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	n/a		Name made current. Taxon reinstated. G.J. Keighery *in litt.* (10/10/2018).
Arthrochilus byrnesii Blaxell	*Phoringopsis byrnesii* (Blaxell) D.L.Jones & M.A.Clem.		Nomenclatural synonym. A.P. Brown *in litt.* (13/06/2018).
Astroloma sp. Dumbleyung (A.J.G. Wilson 146)	*Styphelia* sp. Dumbleyung (A.J.G. Wilson 146)	P3	Name synonymised. M. Hislop *in litt.* (15/05/2019).
Astroloma sp. Eneabba (N. Marchant s.n. PERTH 01291777)	*Styphelia* sp. Eneabba (N. Marchant s.n. PERTH 01291777)		Name synonymised. M. Hislop *in litt.* (15/05/2019).
Astroloma sp. Kalbarri (D. & B. Bellairs 1368)	*Styphelia cernua* Hislop & Puente-Lel.	P2	Taxon formally published. See Hislop & Puente-Lelièvre (2019).
Astroloma sp. Nannup (R.D. Royce 3978)	*Styphelia* sp. Nannup (R.D. Royce 3978)		Name synonymised. M. Hislop *in litt.* (15/05/2019).
Astroloma sp. Narrogin (R.D. Royce 8158)	*Styphelia* sp. Narrogin (R.D. Royce 8158)		Name synonymised. M. Hislop *in litt.* (15/05/2019).
Astroloma sp. sessile leaf (J.L. Robson 657)	*Styphelia angustiflora* Hislop & Puente-Lel.	P2	Taxon formally published. See Hislop & Puente-Lelièvre (2019).
Astroloma stomarrhena Sond.	*Styphelia stomarrhena* (Sond.) Sleumer		Nomenclatural synonym. See Hislop & Puente-Lelièvre (2019).
Astroloma xerophyllum (DC.) Sond.	*Styphelia xerophylla* (DC.) F.Muell.		Nomenclatural synonym. See Hislop & Puente-Lelièvre (2019).
Banksia densa A.R.Mast & K.R.Thiele var. *densa*	*Banksia densa* A.R.Mast & K.R.Thiele	P2	Nomenclatural synonym. No varieties recognised. See Thiele (2019b).
Banksia densa var. *parva* (A.S.George) A.R.Mast & K.R.Thiele	*Banksia parva* (A.S.George) K.R.Thiele	P4	Nomenclatural synonym. See Thiele (2019b).
Banksia densa var. Wheatbelt (M. Pieroni s.n. PERTH 04083407)	*Banksia zygocephala* K.R.Thiele		Taxon formally published. See Thiele (2019b).
Caladenia × *intermedia* (Fitzg.) M.A.Clem. & D.L.Jones	*Elythranthera* × *intermedia* (Fitzg.) M.A.Clem.		Nomenclatural synonym. A.P. Brown *in litt.* (09/01/2018).
Calandrinia sp. Piawaning (A.C. Beauglehole 12257)	*Calandrinia uncinella* Obbens	P1	Taxon formally published. See Obbens (2019).
Calandrinia sp. The Pink Hills (F. Obbens FO 19/06)	*Calandrinia monosperma* Obbens		Taxon formally published. See Obbens (2019).
Clerodendrum heterophyllum (Poir.) R.Br.	n/a		Excluded taxon. PERTH collections represent cultivated material.
Clerodendrum heterophyllum var. *baueri* Moldenke	n/a		Excluded taxon. PERTH collections represent cultivated material.
Comesperma sp. A Kimberley Flora (D.W. Rust 8)	*Comesperma* sp. A Kimberley Flora (D.W. Rust 48)		Error. Correction to voucher-specimen identifier.
Comesperma sp. A Kimberley Flora (D.W. Rust 48)	*Comesperma minutum* A.J.Ford & Halford	P1	Taxon formally published. See Ford *et al.* (2017).
Corybas sp. Peat (A.P. Brown & D. Edmonds APB 4314)	*Corybas autumnalis* A.P.Br. & D.Edmonds	P2	Taxon formally published. See Brown & Edmonds (2019).
Crosslandia setifolia W.Fitzg.	*Fimbristylis crosslandii* Roalson, R.L.Barrett & Larridon		Nomenclatural synonym. See Roalson *et al.* (2019).
Cyanthillium gracilis (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill.	*Cyanthillium gracile* (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill.	P3	Orthographic variant. A.S. George *in litt.* (13/12/2018).

Old Name	New Name	Status	Comments
Cyathostemon sp. Mt Dimer (C. McChesney TRL 4/72)	*Cyathostemon verrucosus* Trudgen & Rye	P3	Taxon formally published. See Rye (2018).
Delosperma vinaceum L.Bolus	n/a		Excluded taxon. See Keighery (2005).
Dillwynia sp. Coolgardie (V.E. Sands 637.3.1)	*Dillwynia acerosa* S.Moore		Informal synonym. M. Hislop *in sched.* (03/10/2019).
Diuris sp. South Coast (G. Brockman GBB 3041)	*Diuris brockmanii* D.L.Jones & C.J.French		Taxon formally published. See Jones & French (2019).
Drosera indica L.	n/a		Excluded taxon. See Lowrie (2013).
Enneapogon nigricans (R.Br.) P.Beauv.	n/a		Name made current. Taxon reinstated. T.D. Macfarlane & U. Bell *in sched.* (21/03/2019).
Eremophila glabra subsp. Kokeby (R. Davis 5080)	*Eremophila glabra* subsp. York (P.G. Wilson 12172 B)	P1	Name synonymised. A.P. Brown *in sched.* (08/02/2017).
Eremophila glabra subsp. *verrucosa* Chinnock	*Eremophila viridissima* Chinnock		Nomenclatural synonym. See Chinnock (2019).
Eremophila oldfieldii subsp. Karara (D. Coultas s.n. PERTH 07341717)	*Eremophila oldfieldii* subsp. *papula* A.P.Br.	P1	Taxon formally published. See Brown & Davis (2019).
Eremophila sp. Kalgoorlie (V. Clark & A. Brown VTC 590)	*Eremophila* sp. Kalgoorlie (V. Clarke & A. Brown VTC 590)		Error. Correction to voucher-specimen identifier. A.P. Brown *in litt.* (30/01/2019).
Eremophila sp. Kalgoorlie (V. Clarke & A. Brown VTC 590)	*Eremophila xantholaema* R.W.Davis	P1	Taxon formally published. See Brown & Davis (2019).
Eremophila sp. Mullewa (R. Wait 7311)	*Eremophila waitii* Chinnock	P1	Taxon formally published. See Chinnock (2019).
Eremophila sp. Rothsay (D. Coultas & J. Kelt s.n. PERTH 08200440)	*Eremophila sericea* A.P.Br.	P1	Taxon formally published. See Brown & Davis (2019).
Eucalyptus gardneri subsp. *ravensthorpensis* Brooker & Hopper	*Eucalyptus ravensthorpensis* (Brooker & Hopper) Gosper & Hopper	P4	Nomenclatural synonym. See Gosper *et al.* (2019).
Eucalyptus obtusiflora subsp. *cowcowensis* L.A.S.Johnson & K.D.Hill	*Eucalyptus obtusiflora* subsp. *dongarraensis* (Maiden & Blakely) L.A.S.Johnson & K.D.Hill		Taxonomic synonym. See Nicolle *et al.* (2019).
Gastrolobium sp. Harvey (G.J. Keighery 16821)	*Gastrolobium capitatum* (Benth.) G.Chandler & Crisp		Name synonymised. See Butcher & Hislop (2019).
Genus sp. Nillup (R.D. Royce 98)	*Hemigenia* sp. Nillup (R.D. Royce 98)	P2	Name synonymised. B.L. Rye *in litt.* (25/02/2014).
Geodorum neocaledonicum Kraenzl.	*Geodorum densiflorum* (Lam.) Schltr.		Taxonomic synonym. R.L. Barrett *in litt.* (08/06/2018).
Geodorum terrestre (L.) Garay	*Geodorum densiflorum* (Lam.) Schltr.		Misapplied name. R.L. Barrett *in litt.* (08/06/2018).
Goodenia campestris Carolin	n/a		Name made current. Taxon reinstated. M.D. Barrett *in litt.* (23/04/2019).
Grewia glabra Blume	*Grewia guazumifolia* Juss.		Taxonomic synonym. See Barrett (2019b).

Old Name	New Name	Status	Comments
Grewia retusifolia Kurz	*Grewia pindanica* R.L.Barrett		Misapplied name. See Barrett (2019b).
Grewia retusifolia Kurz	*Grewia savannicola* R.L.Barrett		Misapplied name. See Barrett (2019b).
Habenaria elongata R.Br.	*Pecteilis elongata* (R.Br.) M.A.Clem. & D.L.Jones		Nomenclatural synonym. See Clements & Jones (2018).
Habenaria eurystoma Schltr.	*Pecteilis eurystoma* (Schltr.) M.A.Clem. & D.L.Jones		Nomenclatural synonym. See Clements & Jones (2018).
Habenaria ochroleuca R.Br.	*Pecteilis ochroleuca* (R.Br.) M.A.Clem. & D.L.Jones		Nomenclatural synonym. See Clements & Jones (2018).
Habenaria sp. Beverley Springs Station (M.D. Barrett MDB185)	*Pecteilis eurystoma* (Schltr.) M.A.Clem. & D.L.Jones		Name synonymised. R.L. Barrett *in litt.* (02/01/2019).
Habenaria triplonema Schltr.	*Pecteilis elongata* (R.Br.) M.A.Clem. & D.L.Jones		Taxonomic synonym. R.L. Barrett *in litt.* (02/01/2019).
Hibbertia sp. Toolbrunup (J.R. Wheeler 2504)	*Hibbertia barrettiae* K.R.Thiele	T	Taxon formally published. See Thiele (2019a).
Hydrocotyle sp. Crassipes (K.R. Newbey 7567)	*Hydrocotyle eichleri* A.J.Perkins	P3	Taxon formally published. See Perkins (2018).
Hydrocotyle sp. Decipiens (G.J. Keighery 463)	*Hydrocotyle tuberculata* A.J.Perkins	P2	Taxon formally published. See Perkins (2018).
Hydrocotyle sp. Hamelinensis (G.J. Keighery s.n. PERTH 02391325)	*Hydrocotyle tetragonocarpa* Bunge		Name synonymised. See Perkins (2019).
Hydrocotyle sp. Puberula (H. Eichler 22058)	*Hydrocotyle scutellifera* Benth.		Name synonymised. See Perkins (2019).
Hydrocotyle sp. Vigintimilia (P.G. Wilson 7940)	*Hydrocotyle papilionella* A.J.Perkins	P2	Taxon formally published. See Perkins (2018).
Lepidosperma leptophyllum Benth.	n/a		Name made current. Taxon reinstated. See CHAH (2012).
Leptocarpus crassipes Pate & Meney	*Leptocarpus scariosus* R.Br.		Taxonomic synonym. B.G. Briggs *in litt.* (13/03/2019).
Leucopogon sp. Barren Range (A.S. George 10092)	*Styphelia quartzitica* Hislop	P2	Taxon formally published. See Hislop (2019).
Leucopogon sp. Bonnie Hill (K.R. Newbey 9831)	*Styphelia sulcata* Hislop & Puente-Lel.	P1	Taxon formally published. See Hislop & Puente-Lelièvre (2019).
Leucopogon sp. Kambalda (J. Williams s.n. PERTH 07305028)	*Styphelia rectiloba* Hislop	P3	Taxon formally published. See Hislop (2019).
Leucopogon sp. Ongerup (A.S. George 16682)	*Styphelia disjuncta* Hislop & Puente-Lel.	T	Taxon formally published. See Hislop & Puente-Lelièvre (2019).
Livistona lorophylla Becc.	*Livistona leichhardtii* F.Muell.		Taxonomic synonym. See Dowe (2018).
Neosciadium glochidiatum (Benth.) Domin	*Hydrocotyle glochidiata* Benth.		Nomenclatural synonym. See Perkins (2019).
Planchonella pohlmaniana (F.Muell.) Dubard	*Planchonella arnhemica* (Benth.) P.Royen		Misapplied name. See Jessup (2019).
Plectranthus congestus R.Br.	*Coleus congestus* (R.Br.) A.J.Paton		Nomenclatural synonym. See Paton *et al.* (2019).

Old Name	New Name	Status	Comments
Plectranthus intraterraneus S.T.Blake	*Coleus intraterraneus* (S.T.Blake) P.I.Forst. & T.C.Wilson		Nomenclatural synonym. See Paton *et al.* (2019).
Plectranthus scutellarioides (L.) R.Br.	*Coleus scutellarioides* (L.) Benth.		Nomenclatural synonym. See Paton *et al.* (2019).
Pleurocarpaea gracilis Lander & P.J.H.Hurter	*Cyanthillium gracilis* (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill.		Nomenclatural synonym. See Thiele & Schilling (2018).
Pterostylis sp. Karri forest (W. Jackson BJ270)	*Pterostylis* sp. crinkled leaf (G.J. Keighery 13426)		Name synonymised. G. Brockman *in sched.* (08/02/2013).
Pterostylis sp. short sepals (W. Jackson BJ259)	*Pterostylis ectypha* (D.L.Jones & C.J.French) D.L.Jones & C.J.French		Name synonymised. G. Brockman & C.J. French *in sched.* (19/12/2018).
Ptilotus macrocephalus (R.Br.) Poir.	n/a		Excluded taxon. See Hammer *et al.* (2019).
Rhagodia sp. Yeelirrie Station (K.A. Shepherd et al. KS 1396)	*Chenopodium nitrariaceum* (F.Muell.) Benth.		Name synonymised. K.A. Shepherd *in litt.* (27/02/2019).
Sauropus crassifolius (Müll.Arg.) Airy Shaw	*Synostemon crassifolius* (Müll.Arg.) I.Telford & Pruesapan		Nomenclatural synonym. See Telford *et al.* (2019).
Sauropus rigidulus (Müll.Arg.) Airy Shaw	*Synostemon rigidulus* (Müll.Arg.) I.Telford & Pruesapan	P3	Nomenclatural synonym. See Telford *et al.* (2019).
Scholtzia sp. Ajana (T.A. Halliday 137)	*Scholtzia bellairsiorum* Rye	P3	Taxon formally published. See Rye (2019).
Scholtzia sp. Ajana East Road (M.E. Trudgen 21734 A)	*Scholtzia truncata* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Billeranga Hills (B.J. Conn 2159)	*Scholtzia subsessilis* Rye	P1	Taxon formally published. See Rye (2019).
Scholtzia sp. Binnu (M.E. Trudgen 2218)	*Scholtzia uniflora* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Binnu East Road (M.E. Trudgen 12013)	*Scholtzia thinicola* Rye	P1	Name synonymised. See Rye (2019).
Scholtzia sp. Binnu-Yuna (M.E. Trudgen 12016)	*Scholtzia longipedata* subsp. *procera* Rye	P3	Name synonymised. See Rye (2019).
Scholtzia sp. Bungabandi Creek (M. Quicke EURA 48)	*Scholtzia peltigera* Rye	P1	Taxon formally published. See Rye (2019).
Scholtzia sp. Burma Road (A.C. Burns 138)	*Scholtzia prostrata* Rye	P3	Taxon formally published. See Rye (2019).
Scholtzia sp. Coburn (N. Murdock NM 031)	*Scholtzia corrugata* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Coomberdale (M.E. & M.E. Trudgen MET 1724)	*Scholtzia halophila* Rye subsp. *halophila*		Taxon formally published. See Rye (2019).
Scholtzia sp. Dongara (R. Hart 8401)	*Scholtzia calcicola* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Duck Pool (M.E. Trudgen MET 5427)	*Scholtzia halophila* subsp. *mortlockensis* Rye	P3	Taxon formally published. See Rye (2019).
Scholtzia sp. East Yuna (A.C. Burns 6)	*Scholtzia inaequalis* Rye	P2	Taxon formally published. See Rye (2019).

Old Name	**New Name**	**Status**	**Comments**
Scholtzia sp. Eneabba (S. Maley 8)	*Scholtzia trilocularis* Rye		Taxon formally published. See Rye (2019).
Scholtzia sp. Eradu (R.D. Royce 8016)	*Scholtzia longipedata* subsp. *procera* Rye	P3	Name synonymised. See Rye (2019).
Scholtzia sp. Eurardy (J.S. Beard 6886)	*Scholtzia oleosa* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Galena (W.E. Blackall 4728)	*Scholtzia truncata* Rye	P2	Name synonymised. See Rye (2019).
Scholtzia sp. Gunyidi (J.D. Briggs 1721)	*Scholtzia quindecim* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Kojarena (A.M. Ashby 1904)	*Scholtzia multiflora* Rye	P1	Taxon formally published. See Rye (2019).
Scholtzia sp. Lancelin (M.E. Trudgen 1516)	*Scholtzia laciniata* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Murchison River (A.S. George 7908)	*Scholtzia denticulata* Rye	P2	Name synonymised. See Rye (2019).
Scholtzia sp. Northampton (A. Strid 20714)	*Scholtzia pentamera* Rye subsp. *pentamera*		Taxon formally published. See Rye (2019).
Scholtzia sp. Overlander (M.E. Trudgen 12138)	*Scholtzia recurva* Rye	P1	Taxon formally published. See Rye (2019).
Scholtzia sp. Prowaka Springs (R.J. Cranfield & P. Spencer 8083)	*Scholtzia brevistylis* subsp. *prowaka* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Red Bluff (A. Gunness 2373)	*Scholtzia longipedata* Rye subsp. *longipedata*		Taxon formally published. See Rye (2019).
Scholtzia sp. Ross Graham Lookout (S. Maley 6)	*Scholtzia denticulata* Rye	P2	Name synonymised. See Rye (2019).
Scholtzia sp. Shark Bay (M.E. Trudgen 7429)	*Scholtzia capitata* Benth.		Name synonymised. See Rye (2019).
Scholtzia sp. Valentine Road (S. Patrick 2142)	*Scholtzia thinicola* Rye	P1	Name synonymised. See Rye (2019).
Scholtzia sp. Winchester (C. Chapman s.n. PERTH 05625386)	*Scholtzia chapmanii* Rye		Taxon formally published. See Rye (2019).
Scholtzia sp. Yandanooka (R. Soullier 646)	*Scholtzia brevistylis* Rye subsp. *brevistylis*	P1	Taxon formally published. See Rye (2019).
Scholtzia sp. Yenyening Lakes (A. Gunness 2824)	*Scholtzia halophila* subsp. *meridionalis* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Yuna (C.A. Gardner 14286)	*Scholtzia cordata* Rye	P2	Taxon formally published. See Rye (2019).
Scholtzia sp. Z-Bend (Bellairs-Kalflora 912a)	*Scholtzia tenuissima* Rye	P2	Taxon formally published. See Rye (2019).
Tephrosia sp. Carnarvon (J.H. Ross 2681)	*Tephrosia gardneri* R.Butcher		Name synonymised. See Butcher (2018).
Tephrosia sp. Fortescue (A.A. Mitchell 606)	*Tephrosia densa* (Benth.) R.Butcher		Name synonymised. See Butcher (2018).
Tephrosia sp. Meentheena (S. van Leeuwen 4479)	*Tephrosia densa* (Benth.) R.Butcher		Name synonymised. See Butcher (2018).

Old Name	New Name	Status	Comments
Tephrosia sp. Onslow (K.R. Newbey 10571)	*Tephrosia gardneri* R.Butcher		Name synonymised. See Butcher (2018).
Tribonanthes sp. Lake Muir (G.J. Keighery & N. Gibson 2134)	*Tribonanthes keigheryi* E.J.Hickman & Hopper		Taxon formally published. See Hickman & Hopper (2019).
Tribonanthes uniflora Lindl.	n/a		Name made current. Taxon reinstated. See Hickman & Hopper (2019).
Tribonanthes variabilis Lindl.	n/a		Name made current. Taxon reinstated. See Hickman & Hopper (2019).
Triodia sp. Robe River (M.E. Trudgen et al. MET 12367)	*Triodia pisoliticola* Trudgen & M.D.Barrett	P3	Taxon formally published. See Barrett & Trudgen (2018).

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Referees for Volume 30

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CONSERVATION CODES
for Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

***The Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.**

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened species

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN Endangered species

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

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[1]The definition of flora includes algae, fungi and lichens.

[2]Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct Species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless

the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

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